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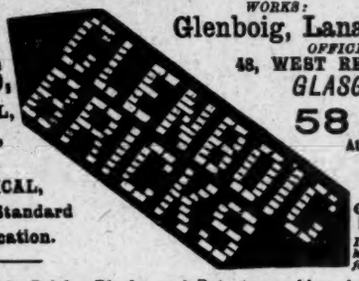

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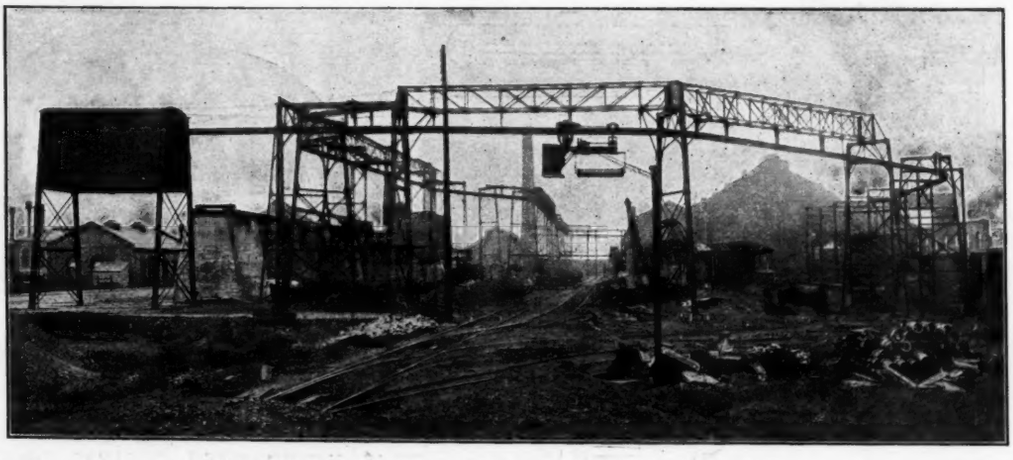

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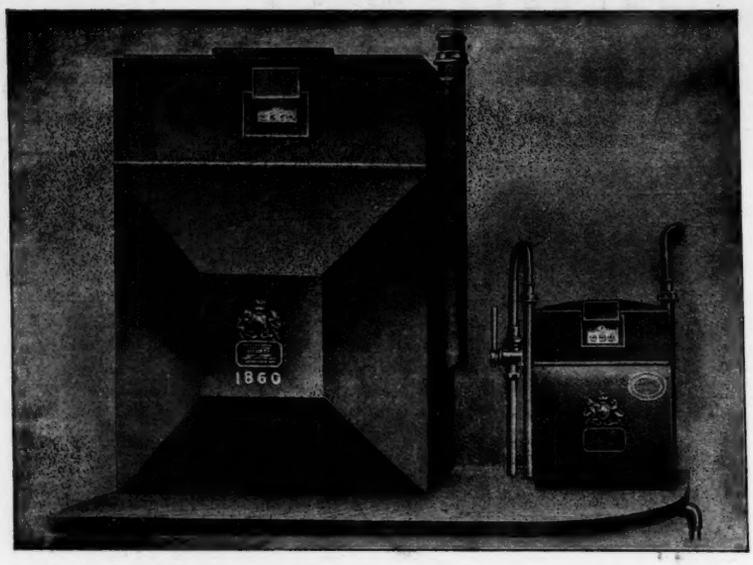

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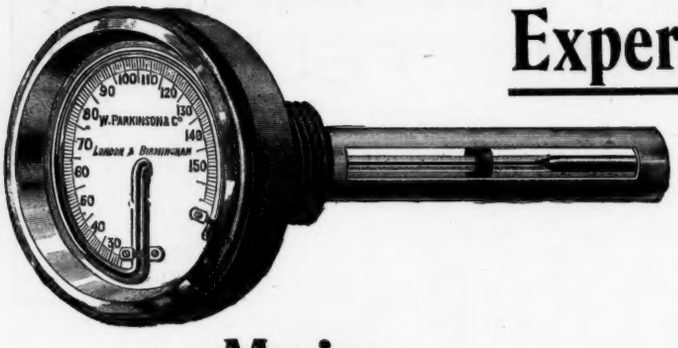

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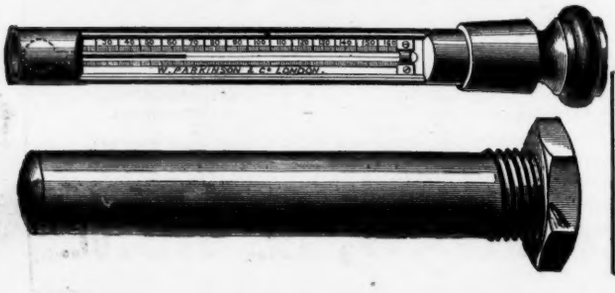

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VOL. CXLIV., No. 2894.] TUESDAY, OCTOBER 29, 1918. [70TH YEAR.

EDITORIAL NOTES.

The Preservation of the War Economies and Higher Efficiencies of the Gas Industry.

THINKING over the Institution meeting—more especially the report of the Gas Investigation Committee, and the discussion upon it, together with the cleverly constructed address that Mr. James Dickson, of Johnstone, delivered to the Scottish Juniors (reported in our pages last week), as well as the discussion introduced by Mr. Tim Duxbury at the meeting of the Manchester Institution last Friday—the question came to mind, Will the gas industry be compelled after the war to renounce its war time produced economies until, undertaking by undertaking, it has obtained the sanction of Parliament to resume them? Nothing has yet been done to ensure the continuity of any economy that has been brought about by advances made during the war under the standards that national necessity has allowed. In short, we are at present proceeding as though there were not in existence such things as General and Private Acts that govern the gas industry in peace times, and which will, as things stand, automatically come into force again when the war is over, or as soon as for war purposes benzol and toluol are not required, and the authority ceases to exist of the Ministry of Munitions to supply coal gas of 500 B.Th.U., less the depreciation caused by oil-washing, and mixed gas of 450 B.Th.U. It is a point worth consideration.

The technical advances that the industry has made during war time have been in several directions; and all of them have more or less a bearing one upon the other. The industry has shown an ability to do things which it has never done before; and opportunity has enabled it to prove a vitality and a capacity for work along paths upon which it has before declined to venture. These things have, while producing economy, demonstrated the power for larger service to the gas consumers, at the same time making greater contribution to the national resources. It is proved by day by day performance how from one ton of suitable coal *plus* the consumption of a comparatively small amount of extra coke, the industry can supply, where vertical retorts and steaming are in use (horizontals are also doing their share, as will be seen shortly), from 16,000 to 17,000 c.ft. of gas of 450 B.Th.U. after oil-washing, with advantage accruing in other directions. Thus every ton of coal is put to better use than before. The ability to do this is in the process; the sanction is the ephemeral one allowed by the Ministry of Munitions. The industry has also shown that it can contribute largely to the benzol resources of the country, with all the contained value of the substance, which value will be required in increasing amount in the approaching times of peace, just as it has been during war time for other purposes. This is a national benefit. So is the increased production of gas per ton of coal carbonized. Mr. Dickson pointed out that if there was only an average additional yield of 2000 c.ft. of gas per ton of coal in the gas industry on its present consumption, there would be a saving of some 3 million tons, which is equal to 15 p.ct. This is something for the Government to consider very seriously. And the Gas Investigation Committee's report, with the discussion, supplies further food for reflection, in that it is shown that efficiency in gas consumption does not depend on the height of the nominal distinction of gas in B.Th.U. The ability to burn the gas to the best advantage is an important thing; and experience accrues which shows that, given a gas of good combustible composition, and even down to 400 B.Th.U. per cubic foot, consumers have not realized the change in the quality of their gas, which points to the fact that they were not, under the former conditions of use, getting the best possible out of it. Lord Moulton and Sir Dugald Clerk told the industry at the Institution meeting that it is the business of its technical men to get into their gas distribution mains per ton of coal carbonized as many B.Th.U as practicable. Mr. Dickson by his average make of 16,193 c.ft. per ton, of an average calorific value of between 450 and 460 B.Th.U., is putting into his mains per ton of coal 7,367,815 B.Th.U.; whereas if he were otherwise producing 12,500 c.ft. of 520 B.Th.U. gas, he would only be putting (after washing) about 6,000,000 B.Th.U. into the mains. On this computation, the increase in B.Th.U. is about 18·5 p.ct. Beyond this, through the increased producing capacity of the retorts, he saves capital charges as well as ground space per unit of production, though probably increasing the wear and tear. But this additional expenditure is certainly well worth incurring. Further, he sees no reason why he should not supplement the make already secured, and supply 400 B.Th.U. gas. But gas is not the only line of economy that has already opened-up to the industry, or that is in prospect, if it only grasps what is freely offered. And, without particularizing here, Mr. Dickson's address will be found to contain much more information of value, especially as to high ammonia yields, the question of tar distillation, and the supply of a good coke.

The point of this article, however, is as to what is going to happen in regard to the accrued economies and higher efficiencies when the war is over, and the nation is not asking the industry to further assist for war purposes? Are the nation and the industry to be debarred from enjoying the fruits of new knowledge until Parliament is persuaded through long drawn-out routine to relax old parliamentary restrictions? There are the Private Bill Authorities. Will they treat progress with contempt if it transgresses in any way the standards for which they appear to have a fixed sentimental regard when once established? We are afraid that unless we can get an investigation by a Committee of a composition that will carry weight and, through the Board of Trade or Ministry of Reconstruction, can persuade Parliament, in the national interests, to continue the good the industry has achieved, there will be an insistence in certain quarters on a complete reversion of the industry to the pre-war position. In other words, the conditions of the industry before the war will be restored; and then there will have to be a protracted struggle to obtain for the industry again those war conditions that subscribe to economy, and which economy must be all the greater with normal conditions in connection with finance, materials, labour, and freedom of working and business. It would be the height of absurdity to put back the clock, and then to have to fight undertaking by undertaking with the view to resuscitating proved serviceable economic conditions made dormant by out-of-date legislation. It is a point that should hasten the appointment of an Investigation Committee either by the President of the Board of Trade or the Minister of Reconstruction. If a Committee so appointed reported favourably, it would not be a difficult matter for Parliament to pass an enabling short measure to tide over a period till Private Acts could be adjusted, so that the gas industry's part in the conservation of coal by the supply of gas suitable to present-day requirements could be continued, while at the same time its best contribution to the benzol supplies of the country need

not be determined. Costs are not going to drop with any violent suddenness. Supplies of coal will, we are warned, continue short and dear for some time ahead; and anyway the price will be at a permanent advance on the pre-war rates. The retreat of the costs of labour will be slow; and it will stop at a point much before the level is reached that represents the old pre-war line. So that Parliament would only be enabling the gas industry to serve the country better by presenting to it the economies and efficiencies that have been brought to light and life during the last four years, accompanied by visions of more to follow. The point as to what is to happen in respect of these economies after the war is one which should receive earnest attention. It is a matter that should be dealt with betimes, in view of the prospect of the war coming to a termination at a time now—it is a thankful thing to be able to hope—not very remote.

No "National" Gas Organization without the Municipal Undertakings.

The last issue of the "Journal" reported the holding in the previous week of meetings of four organizations connected with the gas industry—the National Gas Council, the Institution of Gas Engineers, the British Commercial Gas Association, and the Society of British Gas Industries. The week was a crowded one; but there was one topic that had a considerable amount of private and open discussion at all the meetings, and special reference was made to it by both Lord Moulton and Sir Hallewell Rogers. It was the reconstitution of the National Gas Council. The discussions (private and open) cleared the air considerably; and it can be said with much assurance to-day that the scheme of reconstitution is going through, and will receive a large amount of support. The more that gas men examine the scheme, the more sagacity and foresight they find embedded in it; and even if, at the genesis of the reconstitution, all gas undertakings are not brought into the district bodies, and so into the Council, it is fairly certain that it will not be long before most of those who initially remain outside will see the propriety of entrance and participation. Those who continue to stand aloof will only be disenfranchising themselves, and denying themselves the right to being represented and heard in relation to matters which, being of general importance, will ultimately be made to apply to every undertaking in the kingdom. But this aspect of the matter is not at the moment the most weighty. Gas undertakings may, if they wish it, deprive themselves of active participation; and no one can say them nay. But upon the administrators of every undertaking a responsibility rests of assisting through individual adherence to make unity of voice, authority, and endeavour as complete as possible in the industry. This was the message that Lord Moulton sent broadcast to the industry, and that Sir Hallewell Rogers emphasized. The present gives an opportunity never before presented; and the outlook bids the industry beware that it does not miss this opportunity, and find itself again when it is sharply needed without adequate representation, as it did soon after war came upon the country. In the period of reconstruction, there will be required an organization strong, alert, and potent if the gas industry is really to hold its own.

Sir Hallewell Rogers particularly, and Lord Moulton more generally, deprecated anything being done that would split the representative power of the industry in any way—such as by the company undertakings being in one organization and the municipal concerns in another. Such a division, as we have shown in previous articles, would be disastrous. The National Gas Council had birth in the necessity, which became marked with increasing strength as war conditions developed, of having a central body to speak for the industry. The then organizations had no coherence; so another body was required, with a new bond introduced, in order to cause the different elements to cohere. This has proved effective; but it has not been a National Gas Council of the best composition and representative quality. And no body could be so, nor could it be national, which divided the municipal from the company undertakings. They will not be divided. Sir Hallewell Rogers and Mr. Alderman William Kay, representing respectively the Birmingham and Manchester undertakings, protested against any such idea; and they voice the views of the men directing many other local authority concerns. There has been no visible sign whatever to support the single suggestion of cleavage; and the analysis, made by the writer of a communicated article published in our columns last week, of the differences as he sees them that exist between municipal and company undertakings has not such real bearing as have much broader considerations. "We must not shut our eyes to these differences," said the writer, "or pretend that they do not exist, or true welding can never take place." Though differences do exist, true welding has taken place, as seen by the work of the British Commercial Gas Association, and that of the old National Gas Council. Municipal influence has been of inestimable worth in and to both bodies; and the instruction as to the needs of the industry collectively and of undertakings individually that has culminated in strong support, is largely a growth of close association with the general work of the industry.

We must not let organic differences or differences in local policy interfere with the larger interests of the gas industry. Our mental attitude must be towards the future, not the past. The industry is one indivisible thing with common objects, however the objects are realized; and every day sanctions the hardening of the belief that matters of common cause, despite the character of the ownership of the concerns, are becoming larger in magnitude and of greater moment. Some of the differences between municipal and company gas undertakings are inseparable from the form of ownership; others are largely a product of isolation and want of unity. The latter have been long growing, and will require much effort to extirpate them. But we know of no better way of narrowing and diminishing the differences than by uniting and bringing together, in one organization having common aims, political and economic, the responsible men directing the concerns. We have before us this significant fact, that those municipal gas administrators who have prominently associated themselves with the general work of the gas industry through organization have been most anxious to bring the differences which exist in policy in their particular undertakings nearer to those that apply to ordinary business. And the closer this association becomes the more will the good work go on. Apart from policy, the large municipal undertakings have in the general work of the industry shown themselves progressives of the first order. Look at the research work of Birmingham, and the part so freely taken there in the inquiry into the effects of gas composition upon utilization. Take the free dissemination of experience in engineering and other important matters from Birmingham and Manchester, without citing other places. Look at the liberality with which these and other municipal bodies (too many to be specifically named) have taken part in promoting and defending the commercial interests of the industry as a whole. Are these things to go for naught? Are they not evidence of an indissoluble interest, whatever the character of the ownership of gas undertakings? There is something greater and more far-reaching that appeals to us in considering this question than differences in capital and labour conditions; and as to purely technical questions, which do not concern the National Gas Council in so far as they do not affect policy, they can be safely left to the Institution of Gas Engineers. Said Sir Hallewell Rogers, at the meeting of the British Commercial Gas Association: "It is the spirit of unity, of common effort for the common good, that has attracted me from the outset to the work of the Association; and it is to the broadness of its constitution and of its policy that I attribute much of its striking success." These are phrases that do not come lightly from a man of such experience and position as Sir Hallewell; and the depth of sincerity that we find in them extends, without any qualification whatever, to the work of the National Gas Council.

We have to look broadly at this question of unity, and not let selected details as to differences affect judgment, to the permanent injury of the large and universal affairs of the industry. Discussing the subject of unification and determining upon attitude, let us keep our eyes upon the common interests of the industry. There is enough in them to fully justify and obtain the strongest front that we can present to the world. From what is now being done, if well done, the industry can, when the turmoil of present events and those that will succeed have passed, go on to that interconnection of all organization under the ægis of a National Gas Council which will be a tower of strength to every element of present organization through the bonding together of the gas undertakings of the United Kingdom. To every intelligent man, the possibilities of the projected new fabric are of an order which strengthens hope regarding the future.

Capital Requirements after the War.

The war position and the unenviable situation of the enemy tend to monopolize our minds almost to the exclusion of matters which, if wise, we should individually bring under immediate survey, and upon which we should not only individually but collectively arrive at some determination. To one of these matters Mr. Archibald P. Main addressed himself in the paper he lately read before the Society of British Gas Industries. It dealt with the waste of capital in war, the unprecedented demand for capital after the cessation of hostilities, and the means by which British industry can make the best possible use of the credit and financial accommodation which will likely be available when peace returns to us. The last two matters concern every industry. The first one does so too. But the practical effect of the concern is so microscopical that it is lost among the mass of general regret over the waste. At best, so far as the people who have to pay are concerned, the question of the waste of money through the war is not one in regard to which good will accrue by dwelling upon it. We are glad enough to learn that where war expenditure can be reduced without any loss of military efficiency, it is being done. We know that there has been waste through inefficiency; we know, too, that the part of the money spent on work of destruction which brings no profitable return, is waste. But all the money spent upon the war has not been wasted. It has been in part productive. The wasted part is that which has found its end in destruction which has produced only sheer loss, and nothing effective beyond. It would be impossible to frame any balance-sheet which would show in figures the part of the war expenditure representing waste, and the part that represents gain. But standing to the credit of all the war expenditure is the vital fact that it has wakened-up this country, has made revelation to us of neglected power, has been creative beyond computation, and all to the good of our future place in the world, and all to the bad for that of our enemies, who prior to the war were active where we were passive, were mobile where we were inert, and were ramifying the world, and planning and building in it, in most ambitious style—and successfully. We failed to realize it all until the war came. We have done so since. The expenditure is not all waste capital; a large part is. But the expenditure has saved us from pursuing a course which was favourable to our enemies; and it has established us in ways which will be to our national gain if we do not recede from our new-born resolutions.

As to capital wants and capital uses after the war, Mr. Main was excellent in his survey without committing himself to any definite figures. There is no question that the demand for capital will be of enormous character for repairing destruction, restoring industries, for establishing new ones, and for the development of our trade and commerce at home and abroad. Financial accommodation will be needed for industries throughout the world. The British gas industry will ask for a share for making good the leeway of the past four years and more, and for putting itself into a position for new and enlarged service. With the amount of capital that will be required, conservation and economy will have to be practised. Mr. Main thinks that one of the chief lessons learnt during the war has been that of economy. His view must have been limited to an intelligent few; for extravagance from most Government departments downwards seems to have been particularly rife, and looseness has had high place. The lesson of economy has been studied and learnt only through a system of regulation, coupon, and threatened penalties for disobedience to, or for excess beyond the bounds of, prohibition, and we doubt any considerable general lasting effect when human nature is unleashed, and there is nothing but shortness of means to effect control.

However, economy of capital consistent with efficiency will have to be practised in all directions, whether or not the lesson has been learnt; and the best possible use will have to be made of the available capital, with an eye on the fact that it is a complex system that will need capital, and that every part of the system that is essential (though the value of the productivity varies) will require to have its share. But for some time to come, it seems to us that all new ventures should be closely scrutinized, in order to winnow the chaff from the corn, before allowing subscriptions of capital to be invited from the public. Mr. Main referred to the huge sums that were, before the war, subscribed for unsound ventures of a "wild-cat" nature. The end of the war will give new and extensive opportunity to the promoters of schemes of superficial glittering merit but really unsubstantial worth. Co-operation in industries in the purchasing and the marketing of materials is another means whereby there can be conservation of capital through the decrease of the amount of floating capital required. To this there can be no objection; but a sharp division of opinion comes when Mr. Main shows a certain leaning towards the American system of organizing the work of firms engaged in one form of production, so that each firm specializes in part only of the work of the finished article, by which means concentration of plant and work is secured, instead of duplication. He pictures the savings and economies in words, not in cash; others see the sacrifice of the inspiriting forces of individuality and competition. But to reshuffle our industrial cards in this way (now or at the conclusion of war) would need an expenditure that would not show an immediate reduction in the gross demand for the provision of new capital for industry, but the reverse. These are, in effect, details of a very large problem, which it is for the Government, our banking institutions, and other financial establishments, with good representative men of industry, to jointly consider. For the financing of our industries after the war is a matter of national concern; as upon them we have to depend for discharging our obligations, and they are the sources of national progress and wealth.

Efficiency and Salaries of Technical Juniors.

The greater part of the Presidential Address of Mr. T. H. Poulson, of Stafford, to the Midland Junior Gas Association, was devoted to the subject of pile-work, of which there has been a good experience at Stafford. Pitch pine and reinforced concrete piles, the driving apparatus, and the operations of fixing and driving, all came in for review. The importance of the subject where the nature of the foundations necessitates the use of piles, and buildings and heavy plant have to be carried by them, cannot be gainsaid. In fact, to the engineer there is a sort of fascination about it, as the performance and life of plant have a heavy dependence upon the stability and truth of the foundations. But however fascinating the subject, these are abnormal times; and in them we have, at the behest of the Paper Controller and imperative economy, to make many sacrifices. Hence in large part the section of the address treating of pile-work has had to be abandoned by us.

The address also illustrates the scope for efficiency and economy that there is in gas-works operations, though we have rather prided ourselves upon the little waste there is in gas-works processes, from the thermal and quantitative points of view. The illustrations adopted by Mr. Poulson deal with boiler fuel and ammonia. When it is remembered that out of boilers only something like an average efficiency of 62 p.ct. is secured, it is seen that there is room for substantial improvement; and since in gas-works we realize as ammonia less than 20 p.ct. of the original nitrogen of the coal, there is good ground for seeing whether a more healthy condition of things cannot be secured here, either by preventing ammonia leakage or by improved working. Gas-works offer large scope for the technically qualified assistant engineer to make his presence felt, if he has not above him a chief who will not tolerate or countenance initiative and effort on the part of the assistants, but expect them only to work by rule and method as laid down by him, and will not sanction departure.

But if gas-works offer large scope to competent assistants, working under the supervision of an encouraging engineer, there are a considerable number of gas-works administrators who have a very vague idea as to what is proper remuneration for technically qualified assistants. Mr. Poulson makes a point of this. We have often written on the subject; but it is one of the things upon which some gas-works administrators remain stubborn, probably because they know that assistants cannot themselves put up a very strong fight for the improvement of their position in respect of recompense. The reason is not creditable to the gas-works administrators concerned, as it means that they are taking advantage of an inferiority of power to refrain from making proper quittance for service rendered. Their conception of justice is of low order. There is also something else. The obligations and responsibilities of junior technical officers have advanced; and the qualifications demanded to-day by wise administrators are far in advance of those required, or necessary, in past days. Just as gas engineers desire to get hold of the most efficient plant, so it is to the

advantage of works to have high efficiency in their technical assistants; and whatever is done to encourage and to attract in this direction, the better for the whole industry. But what is frequently seen? That the standard of wages has not advanced *pari passu* with the growth of obligations and responsibilities. For the good name of the industry, and for the future protection of its interests (so far as coming chief executive officials can protect them), there should be a change of policy where inadequate salaries have been offered and paid to the junior technical officials.

Naphthalene Estimations.

Several applications have been made to Dr. Harold G. Colman for details of additional precautions or modified methods of working which have been found advisable in estimating naphthalene in coal gas by the plan published by Colman and Smith some eighteen years ago. Dr. Colman's time is pretty well occupied; and it is difficult for him to reply fully to every individual inquiry. The article by him in another column will supply the information desired; and the notes, receiving general circulation in this way, will satisfy more than those who have already sought additional particulars.

Man Power, Materials, and Fuel.

With the rise of the curve towards the peak load of annual demand, gas-works will not be in the best position for a few months to undertake any reconstruction or extension work, though some of them sadly need it. Deterioration of plant and the demands upon it make it all the more difficult, even if opportunity offered, to enter just at present on renovation or other work. But, although will and availability allowed, a more stringent condition of things has arisen under an Order of the War Cabinet. By this the War Priorities Committee are authorized to issue instructions that no new works, or extensions to works, shall be started, except such as are known to be immediately necessary for winning the war. Any exceptions that it may be sought to make to this rule are to be brought to the notice of the War Priorities Committee, but only on the personal authority of the Minister of the Department concerned. Every Department, too, is to carry out a thorough investigation into its own manufacturing and constructive programme, having in view the altered conditions now obtaining in regard to man power, and the supply of material and fuel. Decision is to rest entirely upon whether works are directly necessary for winning the war. This indicates the position that has been brought about at home by the acute struggle now proceeding; and when things are being subjected to such close rule in the War Departments, industries outside cannot hope for preferential treatment.

The Coal Position.

It is not improving on balance. This is the only conclusion to be drawn from the information just published by the Coal Controller. For the thirty-six weeks of this year, the net shortage of output amounted to 15¼ million tons on the basis of the preceding year's production, or about three-quarters of the coal requirements of the home gas industry. There is now, however, a steady improvement in output owing to the return of miners from the Army to collieries, to the weather not being so favourable for holiday making, and to a reduction of illness among the miners; but, on the other hand, the demand is naturally greater than ever, owing to the season of the year, the efforts that are being made to lay in stock before the bad weather gets to its worst, and the needs of our Allies, of the Armies, and of the allied Navies. At the same time, it is doubtful whether the miners are all responding cheerfully to the appeal to them to do their best. Men in close contact with them report their output per head as not what it could be or has been. At any time, says one authority, the falling-off of production would be a disgrace to the coal industry; in these days it is a crime. Sir Leonard Llewelyn, recently addressing the Cambrian Combine officials and men, pointed out that, if the output of coal was increased by 1 ton per man per week, an additional 50 million tons a year would be produced. This would relieve the country and the Coal Controller from all difficulty—in fact, a Coal Controller might not then be needed, except to see that prices did not take abnormal flight, though truly, as purchasers contemplate the prices now being paid, they pause and wonder. Still, although the coal position is what it is, we hope the Coal Controller will do for the gas industry what he has promised to strive for—give to those gas-works most remote from the collieries a six weeks' stock, and to those nearer four weeks, which is in these times little enough as a margin of safety.

Inerts and Calorific Value of Coal.

A study of the influence of impurities upon the calorific value of coal has been made by Mr. T. J. Drakeley; and he has incorporated the results in a paper read before the Manchester Geological and Mining Society. In one set of experiments, the same coal was taken, and the ash content was varied, with this result: With a total ash content of 3·38 p.ct., the calorific value was 14,191 B.Th.U.; with 13·89 p.ct., 11,346 B.Th.U.; with 24·44 p.ct., 8520 B.Th.U.; with 34·95 p.ct., 5675 B.Th.U.; with 45·46 p.ct., 2821 B.Th.U. Tests with other coals showed the same calorific decline with the upward ascent of the percentage of ash; of course, calorific value varying with the nature of coal used in the experiments. In the purchase of coal according to specification, it is usual to correct the price for variations in calorific value and ash and moisture content. From the experiments by Mr. Drakeley, it might be argued that the ash content adjustment of the price was unnecessary, as it incidentally forms the basis of the calorific value correction. But the argument would not be a tenable one. For example, in boiler practice, it is found that the increase in evaporation observed with a cleaner sample of the same coal is not directly proportional to the decrease in the amount of inert matter in the coal—the fireman being able to use the cleaner coal to much greater advantage. Hence the correction of price according to the variations in the percentage of ash as well as calorific value is essential when coal is bought for industrial purposes on a specific basis.

Coal and Coke Exports.

Notwithstanding the additional needs of our Allies, the shipments of coal, coke, and patent fuel for September show a material reduction—the total being 2,992,327 tons, a decline of 706,239 tons on September, 1916, and of 345,207 tons on September, 1917. The value, however, was higher, though the quantity was so much lower. It was £4,933,848—an increase of £68,816 on September, 1916, and of £347,251 on September, 1917. The average value per ton last month was £1 12s. 11¾d. The nine months' exports total to 26,200,984 tons—a reduction on the similar period of 1916 of 5,241,888 tons, and on 1917 of 3,237,851 tons. The value for the nine months is £38,960,981—an increase of £949,994 on the corresponding period of 1916, and a reduction of £524,374 on that of 1917.

Masonic.

At last Wednesday's meeting of the Evening Star Lodge, No. 1719—the W.M., W. Bro. Fred. West, in the chair—a recommendation of the Standing Committee was unanimously agreed to, that the following brethren be elected Honorary Members of the Lodge: Bro. Samuel Cutler, who joined in 1877; W. Bro. Thomas H. Martin, P.M., who was initiated in 1878, and for many years was Treasurer of the Lodge; and Bro. John West, of Southport—also initiated in 1878.

The Next British Industries Fair.—The 1919 British Industries Fair, organized by the Board of Trade, will be held (as last year) in the Pennington Street Warehouse of the London Docks, from Feb. 24 to March 7. It will again be confined to the same trades as before—one of which is glass. The right to exhibit will be confined to British manufacturers.

Gas from Straw.—It is reported from Saskatoon that the Advisory Council of Scientific and Industrial Research is establishing a plant near the city for experiments to be made during the coming winter on the production of gas from straw. It is estimated that about 20 million tons of straw go to waste annually in the West; and it is stated that at a cost of $500 for the installation of a small plant, it is possible in an hour and a half to produce enough gas to last an ordinary farmhouse three weeks.

Midland Association of Gas Engineers and Managers.—As already announced, the autumn general meeting of the Association is fixed for Thursday of this week. It will take place in the Grand Hotel, Birmingham, at 2 o'clock, under the presidency of Mr. W. Chaney, of Saltley. After formal business, there will be a discussion on the proposed reconstruction of the National Gas Council; some "Notes on Benzol and Naphthalene Recovery, by Mr. H. E. Copp, of Etruria; and a paper on "Chemical Engineering in Relation to Gas Engineering," by Mr. W. A. Twine, of Birmingham.

OBITUARY.

ROBERT B. MAIN.

A long connection with the gas industry was terminated by the much regretted death last Tuesday, following upon a severe operation, of Mr. Robert B. Main (aged 68), the Chairman of Messrs. Glover and Main, Ltd. He will be greatly missed from the meetings of the North British Association of Gas Managers, as well as by the gas industry generally in Scotland. For nearly twenty years he acted as Hon. Auditor to the Association, and only retired in 1909, when he felt that the funds to be dealt with had grown to such an extent that the time had arrived when an accountant should fill the position. He was then elected an honorary member of the Association, and presented with a barometer, as a token of goodwill.

More than fifty years ago Mr. Main entered the service of Messrs. R. Laidlaw & Sons, and with them he spent seventeen years of his business life, becoming in course of time their representative in Scotland and the North of England. Afterwards he and his brother, Mr. Archibald P. Main, under the style of Messrs. R. & A. Main, began business in Glasgow as makers of gas-stoves. This was between thirty and forty years ago. Those were the early days of the industry; but nevertheless, at the end of three years it was found necessary to look round for larger premises, and a foundry at Kinning Park was purchased. Here the growth of the business proceeded apace, until in about 1900 ground was secured at Falkirk, on which the firm built the Gothic Iron-Works, where they entered into the general ironfounding business, in addition to making gas heating and cooking appliances. In 1897 the business was converted into a limited liability company, and amalgamated with that of Messrs. Thomas Glover and Co., of Edmonton. Mr. A. P. Main is now the last survivor of six brothers.

For some years the late Mr. Main was a Town Councillor and Magistrate in the Burgh of Kinning Park; and he was also at one time a County Councillor of Clackmannanshire.

Second Lieutenant Herbert Allen Townsley, who has been killed in action, was the elder son of the late Mr. R. H. Townsley, the General Manager of the Leeds Corporation Gas Department. He was 26 years of age, and at the outbreak of war was in the service of the Leeds Corporation.

The death took place rather suddenly last Friday, of Mr. John Ashworth, who up to a month ago was the Assistant Gas Engineer to the Burnley Corporation. Mr. Ashworth, who was sixty years of age and was at the works on Wednesday last, entered the gas-works as a youth in 1874; being articled to the then Manager, who was the father of the present Manager. He became subsequently Assistant Manager. Two years ago his health began to fail him; and last month the Gas Committee, realizing this, relieved him of his onerous post, and gave him that of Distribution Superintendent. Mr. Ashworth had served the Corporation well for 44 years.

PERSONAL.

Mr. P. O'Brien, the Gas Manager at Ballybay (co. Monaghan), has been appointed to the charge of the Navan (co. Meath) Gas-Works.

Lieutenant J. O'Callaghan, of the United States Army, reported wounded in action, is a son of Mr. P. J. O'Callaghan, the Manager of the Omagh (co. Tyrone) Gas-Works.

The Teignmouth Urban District Council have appointed Mr. Harold Higham, of Shipley, to succeed Mr. J. A. Gray as Gas Engineer. Mr. Higham was Manager of the Shipley Gas-Works for eighteen months, and before that was at Stockport and Bradford. Mr. Gray, who is leaving to take up the position of Gas Engineer and Manager to the Ashton-in-Makerfield Urban District Council, has been presented by the employees at the Teignmouth Gas-Works with a silver table centre, as a token of esteem, and with wishes for his success in his new sphere. It was mentioned by Mr. C. G. Cedrick, who was deputed to present the gift, that it had been subscribed for by the entire staff.

Mr. Charles F. Tooby, who was recently appointed Works Superintendent of the Foleshill Gas-Works of the Coventry Corporation, entered the service of the Birmingham Gas Department in 1905. After four years' training in the laboratories and on the various stations, including the large experimental works at Saltley, he filled the positions of Assistant at the Adderley Street works, Junior Engineer at Windsor Street, and for the last five years Resident Assistant Superintendent at Saltley. He has passed first class in both the ordinary and honours grades of "Gas Engineering," has matriculated at London University, and passed in Mechanics, Engineering Drawing and Design, Chemistry, Heat, Magnetism, and Electricity at the Intermediate B.Sc. (Engineering) of London University. On the 3rd inst., Mr. W. Chaney (the Engineer of the Saltley and Adderley Street works), on behalf of the staff and employees of the Birmingham Corporation Gas Department, presented Mr. Tooby with a mahogany cased clock, an electro-plate tea service and salver suitably inscribed, and an aneroid barometer in oak case, as marks of the esteem in which he was held.

TEMPORARY INCREASE OF CHARGES ACT.

Among further Orders made by the Local Government Board under the Statutory Undertakings (Temporary Increase of Charges) Act, is one for the Bakewell Urban District Council, whose maximum price of 4s. per 1000 c.ft. for gas supplied within the district or outside the district within a radius of 1530 yards from the Town Hall at Bakewell, is raised to 5s.

The Leeds Corporation have power under their last Act to charge 3s. 6d. per 1000 c.ft.; and under the Order, this figure becomes 4s. 2d.

In the case of the Poulton-le-Fylde Urban District Council, the maximum price of 4s. 6d. per 1000 c.ft. is increased to 5s. 6d.

The Board of Trade have made Orders under the Act in favour of the following companies:

Tadcaster and Wetherby District Gaslight Company.
Llanidloes Gas Company.
Commercial Gas Company.
South Oxfordshire Water and Gas Company.
Long Melford Gas and Coke Company.

They have received the following additional applications for Orders:

Aberdare and Aberaman Consumers' Gas Company.
Dundalk Gas Company.
Maidstone Gas Company.
West Cheshire Water Company.
Rochford Gas Company.

Applications for Orders have also been received by the Local Government Board from:

Pontefract Corporation.
Teignmouth Urban District Council.

In connection with their application to the Board of Trade for an Order, the South Suburban Gas Company point out that the standard dividend on the Company's ordinary stock is 5 p.ct. per annum; and the standard price of gas supplied by meter, under the South Suburban Gas Act is 2s. 9d. per 1000 c.ft., with increase or reduction in dividend below or above this price. In the case of the West Kent stock, increases and decreases in dividend are to be calculated upon decreases in the price of gas below 2s. 4d. per 1000 c.ft., and increases above the standard price of 2s. 9d. With both these stocks, the price regulating the authorized dividend is that charged in the Company's South Suburban district. As to the remainder of the Company's district, the price exceeds the price of the South Suburban district by 7d. per 1000 c.ft. (subject to reduction after June 30, 1919) in the Bromley district and the parishes of Cudham, Downe, Halstead, and Shoreham, and by 1s. 2d. per 1000 c.ft. (subject to reduction after June 30, 1922) in the West Kent district.

INSTITUTION OF GAS ENGINEERS.

At the last Meeting of the Council of the Institution of Gas Engineers, the following candidates were passed for the next ballot-list.

As Members.

Thos. Carmichael, Portsmouth.	P. N. Langford, Coventry.
Hedley Hoy, Cannock.	R. C. Macdonald, London.
P. S. Kitto, Sutton.	F. A. West, Newark.

As Associate Members.

T. H. Poulson, Stafford.	F. L. Smith, Reigate.

Transferred from the class of associate member to that of member.

J. T. Turpie, Grange-over-Sands.

The Council have also recently admitted as students the following gentlemen. These admissions have resulted from the decision of the Council to invite those who have passed the City and Guilds of London Institute Final Examination in "Gas Engineering" in 1918 to apply for studentship, and were the outcome of a suggestion by Mr. A. E. Broadberry.

E. Arthur, Birmingham.	S. Smith, Bradford.
W. I. Ineson, Bradford.	T. A. V. Tayar, Birmingham.
J. F. Lloyd, Wrexham.	H. Wadsworth, Bingley.

The Council granted an Institution Gas-Fitters' Certificate to Mr. Ernest L. Oughton, of Huddersfield, on the recommendation of the Manchester District Institution of Gas Engineers.

Refractory Materials Committee Report.

The following letter in reference to the report of the Refractory Materials Committee submitted at the recent meeting has been received by the President of the Institution (Mr. Samuel Glover) from Dr. J. A. Harker.

Ministry of Munitions,
Princes Street, Westminster, S.W.
Oct. 18, 1918.

Dear Mr. President,—Duties at the Munitions Inventions Department concerning urgent work connected with the visit of an important

delegation from our American Allies, will prevent me from being present this afternoon at your meeting, when I understand the report by Dr. Mellor of the work undertaken for the RefractoriesCommittee will be read.

It was only late last evening that I had an opportunity of studying the report; and I have not seen the materials on which the experiments were conducted. It is therefore rather difficult to add to the discussion anything of value, seeing that the subject is such an entirely new one, and Dr. Mellor and Mr. Emery appear to be breaking entirely new ground in this piece of pioneering research.

It will, however, certainly be a matter of interest to those gas engineers whose retorts and settings have suffered by the contaminating influence of flue dust to examine very carefully the conclusions which the authors have arrived at in the paper. I certainly agree with them that the influence of the different kinds of dust is a very profound factor on the time that a structure subjected to their deleterious action can stand up to its work.

With regard to the general work of the Refractories Committee, I think its members would all be willing to admit that their record of things done during the past year might easily have been a longer one; but remembering the difficulty of getting anything done at all under the actual circumstances, the Institution might be willing to bear with them, and perhaps re-appoint them with the hope of more tangible things to come under the brighter circumstances which seem to be fast approaching. Under the able leadership of Dr. Colman, whose resignation as Chairman of the Committee we all profoundly regret, the Committee has continued its work; and I think it is to be congratulated on the recognition of its labour by the Department of Scientific and Industrial Research.

Is it too much, Sir, to say that, while other people have been "talking" about refractories, we have been—with all our disabilities—"trying to get on with the job?"

(Signed) J. A. Harker,
Director of Research, M.I.D.

The Secretary asks us to announce that the Council will be glad to receive by Nov. 9 any written observations on the preliminary report of the Gas Investigation Committee which was presented at the meeting on the 17th inst.

ELECTRICITY SUPPLY MEMORANDA.

Life and duty demand something more than concentrating on fuel rationing and equivalents; and shortage of staff causes us to do things which we should not otherwise do, and to leave undone things which would, in different circumstances, be done. The writer of these "Memoranda" finds it quite impossible in the present days to keep pace, with day-by-day precision with all correspondence that reaches him. Moreover, it is necessary in these times, owing to pressure, to get somewhat in advance with the preparation of matter for publication; and it is also essential to give preference to certain matters over others. Hence the apparent neglect of Mr. Ed. C. de Segundo's letter, which appeared in our issue for the 15th inst., dealing with comments in the "Memoranda" for the 8th inst., and hence, too, the appearance of the note in the "Memoranda" for the 15th inst., which note, it was explained at the time, was in type before Mr. de Segundo's letter to our columns was received. The mention of the letter, however, directed the attention of interested readers to its explanations. These, of course, put a different complexion upon what turned out to be an unrevised and mutilated publication of the contribution to the "Electrical Review." It may now be said that, if we are not able to agree every one of his figures, Mr. de Segundo's communication to the "Journal" columns shows that he is nearer to our own calculations than the first article in the "Review" suggested. Any complaint that he has to make must lie at the door primarily of the "Electrical Review." But whatever Mr. de Segundo, Mr. Arthur H. Barker, or anyone else chooses to say cannot necessarily be accepted by an industry with its own engineers, chemists, and analysts, and a mass of day-by-day experience which no one outside it can possibly have. Our figures are based largely on averages, and not on exceptional conditions and results—high or low. The coal used in gas-works is not the same throughout the country. In some cases, very high makes are obtained; in others, as in Wales and parts of the South-West district, the production per ton may be as low as 10,000 c.ft. In these times, too, ash and dross content is generally much greater than usual; but it varies considerably even in the deliveries to the same works of coals from different collieries. The depreciation in the electrical engineers' fuel is not greater in proportion to that of the gas engineers' fuel. In the foregoing are reasons for considerable variation in the gas make per ton of coal as between works; hence, too, the appreciable variation in the quality of coke from different coals. One man's experience in these days is not that of another man; one sample of coke is not as another sample. Therefore, in our recent criticism, we adopted figures that may be taken as about average ones in the circumstances of those undertakings that are representative of good working and the dealing with the major part of the coal carbonized. Nothing that Mr. de Segundo said in his letter which appeared in our issue for Oct. 15 demands any revision of our figures in connection with manufacture and utilization results.

In Closer Agreement.

Gas Production and Fuel Use.

We read in Mr. de Segundo's letter that he "adopted the figure of gas per ton of coal distilled as the average performance for large and small plants throughout the kingdom on the authority of a gentleman who certainly ought to know what he is talking about." Whoever this gentleman is, he certainly did not know what he was talking about, or, if he did, he did not tell Mr. de Segundo all he should have done. The last issued Board of Trade gas returns deny his authority. Besides, Mr. de Segundo must admit it is not the average performance of large and small plants throughout the kingdom that matters, but the average performance per ton of coal. Now let us take, with wartime coal, the working results of Metropolitan and Suburban companies for the half year ended December last, and not all working with Durham coal. Some of the coal came from Durham, some from Yorkshire, some from the Midlands. It is found that the Gas Light and Coke Company made an average per ton of coal of 11,971 c.ft.; the South Metropolitan Company 12,318 c.ft.; the Commercial Company, 12,630 c.ft.; the Wandsworth Company, 12,256 c.ft.; the South Suburban Company, 11,810 c.ft.; the Tottenham Company, 12,078 c.ft.; and the Brentford Company, 11,717 c.ft. Some of these Companies only meet annually now; so that their figures are not available for the June six months of this year. But here are the averages with wartime coal for some of them for last half year: South Metropolitan Company, 11,942 c.ft.; Commercial Company, 13,037 c.ft.; Wandsworth, 12,276 c.ft.; South Suburban, 11,569 c.ft.; Tottenham, 12,444 c.ft. The South Metropolitan Company do not make carburetted or blue water gas; but in the case of all the other Companies, they added the following percentages to their makes of coal gas last December half year: Gas Light and Coke Company, 20·12 p.ct.; Commercial, 27·69 p.ct.; Wandsworth, 9·56 p.ct.; South Suburban, 20·62 p.ct.; Tottenham, 39·8 p.ct.; Brentford, 41·51 p.ct. In the past June half year, the Commercial Company added 26·52 p.ct.; Wandsworth, 21·83 p.ct.; South Suburban, 22·82 p.ct.; Tottenham, 24·77 p.ct. Somewhere in the neighbourhood of 30 lbs. of coke are required per 1000 c.ft. for the manufacture of blue water gas; somewhat more for carburetted water gas. From these particulars, Mr. de Segundo will see there was excellent ground for questioning his average performance of 10,000 c.ft. per ton of coal for large and small plants throughout the kingdom. Not one of the Companies named is using continuous vertical retorts and steaming the charges, which produce variously, according to the suitability of coal, from (say) 14,500 to 16,000 or 17,000 c.ft. per ton, with a slight reduction of the coke made for sale. The same "authority" who quoted the 10,000 c.ft. per ton appears to be the gentleman who accepted Mr. de Segundo's plan of adding to the 1½ tons of coal, which he had assumed were required to produce 15,000 c.ft. of gas, the fuel used in heating the retorts, notwithstanding that it is part of the coke product of the 1½ tons. Mr. de Segundo submitted to him that so far as the Coal Controller is concerned, it was immaterial whether this particular quantity of coke was consumed in heating retorts, or burnt by the householder, or in the boilers of electric generating units. In either case it constituted a draft upon the fuel at the disposal of the Controller. The friend "seized the point at once." "A trifle hasty, was it not?" The quantity of coke used to heat retort-settings never has been available to the Coal Controller; and no coke could be until the coal is carbonized by the use of the necessary part of the coke produced. And it is a very material thing to the Coal Controller whether this part of the coke is consumed in heating retorts, or burnt by the householder, or in the boilers of electric generating units. It is the most economical use of coke, as passing direct in its incandescent state into the retort-furnaces, a large quantity of heat which would otherwise be lost by quenching is put to profitable use. Our figures, given in the "Memoranda" for Oct. 8, set forth the net use of fuel for gas production, and the net amount of "fuel" liberated for the use of the Controller. There is nothing material in this point as presented by Mr. de Segundo; it only makes a peg for a little futile argument. The position is not altered one iota.

The "Effective" Heat from Gas-Fires.

Now we come to the question of gas-fires, to the losses attributed to which Mr. de Segundo made extravagant statements, when examined in the light of present-day knowledge and present-day gas-fire production. This is what he has said:

Original Article.	*Letter in "Journal" for Oct. 15.*
In some types of gas-fire, the percentage of heat lost may be higher than 90 p.ct. In gas-stoves connected to a flue (as, of course, they all should be), even assuming the combustion to be complete, certainly over 50 p.ct. of the heat will be lost as far as radiation into the room is concerned.	I do not think I am far wrong in my views upon the waste of heat "in some types of gas-fire." I have had some practical experience in this direction. Nor do I think you should quarrel with my estimate of 55 p.ct. (not 90 p.ct.) loss in average gas-stoves used in average households by average householders.

In one respect we like the quotation from the letter better than that from the original article. In the other respect, we like the quotation from the original article better than that from the letter. The letter rejects the 90 p.ct. loss as something that is not usual. The original article referred to over 50 p.ct. of heat being lost so far as radiation into the room is concerned; the letter asserts defi-

nitely an "estimated" loss of 55 p.ct. We have good grounds for quarrelling with the estimate of 55 p.ct. loss. Given gas-fires as now constructed (which types were put on to the market two or three years before the war, and had a remarkably rapid adoption), with proper regulation and general structure so as to give a good part of the heat in the radiant form, the percentage of measured radiant heat will reach close upon 50 p.ct., and in some cases it exceeds 50 p.ct. Where regulation is imperfect, the percentage of radiant heat may be as low as 40 p.ct. But when the waste gases prove a loss of only 20 to 25 p.ct. (not 55 p.ct.) it may be taken that convection and conduction contribute to the heating of the room the difference between the radiant heat and the heat losses up the flue. Therefore we cannot accept Mr. de Segundo as a safe guide in this matter. We, too, have practical experience in this direction, as well as results of tests of many kinds, made in different places, and by men whose work is beyond question. And there we may leave the matter.

The Finance of a National Kitchen and Restaurant.

The Wandsworth National Kitchen appears able to claim that it is paying its way. There are a number of so-called National Kitchens in the country that have not paid their way; and there are some of them that have had to be closed fairly early in their careers through their failure to excite anything but a passing and torpid interest from the public. The Wandsworth venture has a restaurant attached to it; and, so far as we have seen, the greater number that are a success have had restaurants attached to them. It is almost ludicrous to notice how, where electricity is used, our electrical friends seem to entertain the notion that it is due to the electricity that success has been achieved; whereas the cost of electricity and other fuel has small part in the outgoings. There are other things that make for success; and, as a matter of fact, the patrons of National Kitchens do not care a jot whether coal, gas, coke, or electricity is the "fuel" used, so long as in war time they can get good value for their money, and good attention in comfortable and clean surroundings. The "Electrical Times" prints a balance-sheet for the Wandsworth Kitchen for the ten weeks ending Sept. 28. The income during that period is given as £771 18s. 10d.; and, adding £1 4s. 9d. for deductions from wages for National Health Insurance, and £82 8s. 4d. the value of goods in hand, credit is taken for £855 11s. 11d. The disbursements amounted to £642 15s. 1d.; so that the balance is £212 16s. 10d. Out of the £642 15s. 1d., only £16 9s. 8d. was for electricity at the (for war times) low price of 1d. per unit *plus* 15 p.ct. and an odd four units, at 4½d. *plus* 30 p.ct., for lighting. So that we guarantee the balance of £626 5s. 5d. had more to do with the attractiveness of the kitchen than the electricity used. It is seen, too, that 13,900 c.ft. of gas were consumed at 3s. 5d. per 1000 c.ft., amounting to £2 7s. 6d. Thus electricity delivered to the kitchen 11,764,800 B.Th.U. for £16 9s. 8d.; gas, 6,950,000 B.Th.U. for £2 7s. 6d. In other words, gas delivered about 60 p.ct. of the heating value of electricity at one-seventh the cost, and Wandsworth gas is normally in the neighbourhood of 2s. per 1000 c.ft. But about the so-called profit-balance of £212 odd, we see nothing charged for interest, wear and tear, and replacements on the £1650 spent on equipment, nor is there a penny piece charged for water, steam, or rent. Therefore, the amount mentioned is not by any means all "profit." There are caterers who, from what they know of the actual charges, would make the balance-sheet look far different.

The "Magna" Midget Light.

In order to meet the national need for fuel and gas economy, says the "Ironmonger," Mr. E. A. Wood, of Aston Road, Birmingham, is manufacturing a novel type of burner and fabricated fitment to enable gas consumers to have the advantage of a bright incandescent light with a minimum consumption of gas. The burner is designed to consume only ½ c.ft. of gas per hour; and for this expenditure it yields a bunsen flame of high calorific power. In front of the burner (to which it is attached by a metal clip) is a metal frame enclosing a square of fabric similar to that used in the manufacture of incandescent mantles. The flame impinges upon this; renders it incandescent; and furnishes a bright light—quite sufficient for halls, landings, staircases, bath-rooms, bed-rooms, and similar places. Reckoning the cost of gas at 3s. 4d. per 1000 c.ft., it is claimed that the "Magna" light will give 50 hours of good light for 1d. The burner is adaptable to any existing gas-fitting, either upright or inverted. It yields the best results when the burner is fitted horizontally, which can be accomplished by the use of a small elbow.

Progress of Applied Chemistry.—We have received from the Society of Chemical Industry (and shall take an opportunity of noticing more fully) Vol. II. (1917) of "Reports of the Progress of Applied Chemistry" issued by the Society. It includes contributions on "Fuel," by Prof. J. S. S. Brame; on "Gas, Destructive Distillation, and Tar Products," by Mr. E. W. Smith, D.Sc.; and on "Mineral Oil," by Mr. W. J. A. Butterfield, M.A. The price of the book is 4s. 6d. to members of the Society, and 6s. 6d. to others, post free. It is published by Messrs. Harrison & Sons, Nos. 44-47, St. Martin's Lane, W.C. 2.

ESTIMATION OF NAPHTHALENE IN COAL GAS.

By Harold G. Colman, D.Sc., Ph.D.

A number of requests have been received asking for details of additional precautions or modified methods of working which have been found advisable in estimating naphthalene in coal gas by the method published by Colman and Smith eighteen years ago [see "Journal," Vol. LXXV., p. 798]. The notes given below are made in answer to these requests.

Apparatus.

The apparatus consists of a train of four wash-bottles, the first in series being of glass throughout, and the second, most conveniently, a narrow mouthed bottle of about 250 cc. capacity, fitted with a rubber stopper carrying an inlet and outlet tube. The first bottle is charged with a 10 p.ct. solution of citric acid, to remove any ammonia present in the gas, which would otherwise be absorbed by the picric acid and count in the test as naphthalene. The second is charged with 100 cc. of N/20 picric acid; and the third with 50 cc. of the same solution The fourth is left empty as a "catch" for any picric acid solution which may be carried along mechanically with the gas stream. The wash-bottles are connected together by rubber tubing, but in such a manner that the ends of the glass tubes joined meet within the rubber joint, so as to expose no material amount of rubber surface to the gas; naphthalene being rapidly absorbed by rubber. The citric acid wash-bottle should be of glass throughout; but rubber stoppers may safely be employed for the remainder, as all but traces of naphthalene are removed from the gas after the first passage through the picric acid solution, and before it can come into contact with any of the rubber stoppers.

Connection to the Gas Supply.

The connection to the gas supply must be made by means of glass or clean metal tube. Here, also, where rubber tubing is used for connection, the ends of the tubes joined must meet within the rubber joint. The connection should be as short as practicable, and made to a main or service through which a good stream of gas is passing continuously. Where a long connection cannot be avoided a T-piece is placed at the inlet to the first wash-bottle. A connection is also made at this point to a burner; so as to ensure that a more rapid stream passes through the long connection than the slow stream required to be passed through the test apparatus—the burner being kept alight during the whole time of the test. Wherever possible, the gas should be taken off before it passes through old service pipes, which, if corroded internally, may cause a considerable reduction in the amount of naphthalene in the gas before it reaches the test apparatus.

Preparation of the Standard Picric Acid Solution.

This may be conveniently prepared as follows: About 35 grams. of picric acid is dissolved in about 600 cc. of boiling water, and the hot solution poured into a Winchester quart bottle containing about 1800 cc. of cold water, and the contents then well mixed by shaking. When cold, the solution is filtered from separated picric acid, and 50 cc. of the filtered solution titrated with decinormal caustic soda, using lacmoid or phenol-phthalein as indicator. With lacmoid, when acid, the colour of the solution is reddish brown, changing to green when alkaline, and with phenol-phthalein shows only the yellow colour of picric acid when acid, changing to yellowish red when alkaline. Observers having a tendency to colour blindness cannot employ lacmoid, as they are often unable to observe the change to green at all, or only indefinitely, and should therefore employ phenol-phthalein. From the amount of N/10 NaOH, required to neutralize 50 cc. of the solution, the quantity of water necessary to add to make the solution exactly 1-20th normal is calculated. Thus, for example, if 50 cc. of the solution required 27·5 cc. of N/10 NaOH for neutralization, the amount of the solution required to make up 2500 cc. of 1/20 the normal solution is—

$$\frac{2500 \times 25}{27{\cdot}5} = 2273 \text{ cc.}$$

Therefore, 2273 cc. of the solution is taken and diluted to 2500 cc. with water; and, after well mixing, a further test of 50 cc. is made, which should then exactly neutralize 25 cc. of N/10 NaOH.

Carrying-out the Test.

The apparatus, after charging with citric acid and picric acid solutions, and connecting to the gas supply (with the precautions given above), is tested for tightness by closing the outlet of the last wash-bottle and turning on full gas pressure, when no gas should bubble through the solution after the first few seconds. The connection from the last wash-bottle to the meter may be made of rubber tubing, as all naphthalene has then been removed from the gas. The gas is then allowed to pass through the apparatus at a rate not exceeding 1 c.ft. per hour, until about 10 c.ft. have passed, and then shut off; the temperature of the gas and the barometer being noted at the beginning and end of the test as well as the volume of gas passed, and the volume corrected to 60° Fahr. and 30 in. barometer in the usual way.

A convenient method of maintaining a regular stream of gas of the required speed is to insert in the tube connecting the wash-bottles with the meter a piece of glass tube drawn out to a fine jet. By carefully heating the jet in a bunsen flame, the size of the

orifice can be reduced to an extent to give a speed of about 1 c.ft. per hour with the gas pressure prevailing at the point where the test is taken. The jet is next inserted in the connection between the wash-bottles and the meter, and the gas supply tap is then fully opened.

The contents of the second picric acid bottle and any splashings in the last bottle are washed into the first picric acid bottle, and this bottle closed by a tight-fitting rubber stopper fitted with a glass stopcock. In place of the latter, the following device may be used. A piece of glass tube is fused off at one end, and a small hole blown in the side of the tube about half-an-inch from the closed end. This tube is then placed in the rubber stopper, so that the closed end goes inside the bottle with the hole in the side below the bottom of the stopper. The bottle is to be evacuated by means of an air-pump or filter pump. A sign of sufficient evacuation is the rising of the naphthalene picrate precipitate to the surface of the liquid; the gas bubbles evolved from the solution by the evacuation attaching themselves to the solid particles and causing them to rise. The stopcock is then closed, or the tube drawn up so that the side hole is well within the stopper.

The bottle is then placed in a water bath containing cold or warm water, the latter heated to boiling, and the bottle occasionally shaken until all naphthalene picrate has dissolved. It is also advisable to place a bent piece of wire gauze in the bath below the bottle, to prevent the latter coming in contact with the heated bottom of the bath. It is then allowed to cool completely, with occasional shaking to redissolve any naphthalene which may condense in the upper part of the bottle not filled with liquid.

Titration of the Resulting Solution.

Working in this manner, the whole of the naphthalene from the gas is converted into naphthalene picrate. In the method as originally given in 1900, this naphthalene picrate was filtered off on the pump and finally washed with a small quantity of water. As naphthalene picrate is dissociated by water, too low results are obtained if more than a small quantity of water is used. To avoid errors from this source, the following procedure, which avoids all washing with water, is adopted: When cold, the contents of the bottle are poured into a 250 cc. measuring cylinder, and the total volume noted. The naphthalene picrate is then separated by filtering through a dry filter paper, rejecting the first few cubic centimetres of the filtrate, which are weaker than the rest owing to picric acid being taken up from it by the filter paper. The remainder of the filtrate is then collected, and 100 cc. of it titrated with N/10 NaOH using lacmoid or phenolphthalein as indicator. The same indicator must be employed as was used in standardizing the picric acid solution.

Calculation of Results.

From the quantity of N/10 NaOH required, and the data of the volume of 1/20 normal picric acid solution taken, the volume of picric acid solution after heating, and the corrected volume of gas passed, the amount of naphthalene in 100 c.ft. of gas may be calculated as follows: The original volume of 150 cc. of N/20 picric acid solution taken neutralized 75 cc. of N/10 NaOH; and the volume of N/10 NaOH required to neutralize the picric acid still contained in the heated solution is found by multiplying the number of cubic centimetres of N/10 NaOH required for 100 cc. by the total of the solution found, and dividing by 100. The difference between the two figures gives the number of cubic centimetres of N/10 NaOH, corresponding to the naphthalene removed from the volume of gas passed. Each cubic centimetre of N 10 NaOH corresponds to 0·0229 gram of picric acid, and therefore to 0·0128 gram, or 0·1975 grain, of naphthalene.

Therefore, if V is the volume of N/10 NaOH required to neutralize the volume of N/20 picric acid taken, and V^1 the volume of N/10 NaOH required to neutralize the total volume of picric solution after heating and filtering, then

$$\text{Grains of naphthalene per 100 c.ft.} = \frac{(V - V^1) \times 100 \times 0{\cdot}1975}{\text{volume of gas passed.}}$$

Thus, for example, if 150 cc. of N/20 picric acid solution are taken, requiring 75 cc. of N/10 NaOH to neutralize it (V), and

Volume of heated solution . . . . . = 188 cc.
N/10 NaOH required for 100 cc. of heated and filtered solution . . . . . = 36·2 cc.
Volume of gas passed, corrected . . . . = 10·8 c.ft.

Then

$$V = 75{\cdot}0 \text{ cc.} \quad V^1 = \frac{36{\cdot}2 \times 188}{100} = 68{\cdot}06 \text{ cc.}$$

$$\text{and } V - V^1 = 75{\cdot}0 - 68{\cdot}06 = 6{\cdot}94 \text{ cc.}$$

Therefore

$$\text{grains of naphthalene per 100 c.ft.} = \frac{6{\cdot}94 \times 100 \times 0{\cdot}1975}{10{\cdot}8} = 12{\cdot}7 \text{ grains.}$$

Patents and Designs Bill.—On behalf of the President, Mr. G. J. Wardle (the Parliamentary Secretary of the Board of Trade) received on the 10th inst. a deputation representing technical and scientific institutions in connection with the amendment of the patent law. Among them, the Institution of Gas Engineers were represented by Mr. Samuel Glover and Mr. Walter T. Dunn, the Federation of British Industries by Sir Robert Hadfield, and the Society of Chemical Industry by Mr. Walter F. Reid.

SIXTY YEARS AGO.

[From the "Journal" for October, 1858.]

Hills's Gas Purification Patent.—In another part of our columns will be found a letter from Mr. Hills, complaining of the tenour of our articles upon the recent trial *Hills v. London Gas Company*, and containing an ingenious, if not an ingenuous, defence of his own position. Now, Mr. Hills must know perfectly well that, in our capacity as public journalists, it is our province to give expression, and sometimes to give very strong expression, to our opinions upon the passing events of the day. In reference to this trial, however, we abstained, to a great extent, from any expression of opinion, and confined ourselves principally to an analysis of the points of the case, and of the evidence bearing upon them. Our articles were, in fact, mere elaborations, and in many parts even paraphrases, of the Judge's summing-up. The report of the trial occupied sixty-four of our columns; and as many of our readers would probably object to wade through such a mass of evidence and argument, we gave what we conceived, and still conceive, to be a clear and fair abstract of the whole case. It was no fault of ours that the evidence bore hardly on Mr. Hills; and he ought not to upbraid us on account of a circumstance for which we are in no way responsible. Had we misrepresented the evidence, Mr. Hills might reasonably have complained; but surely we are not to blame, even if the defendants did rely upon what Mr. Hills is pleased to call "staggering propositions" and "barefaced mystifications." Mr. Hills virtually alleged that the London Gas Company were endeavouring to cheat him out of his just rights; and the London Gas Company virtually alleged that Mr. Hills was endeavouring to cheat them out of royalties to which he had no title whatever. We gave the allegations on both sides, and the evidence by which each was supported. The propositions that Mr. Hills had patented the crudest notions of his brain, that he was a man eager to patent anything, &c., are not our allegations, but those of the London Gas Company. If, however, anyone is anxious to know on what grounds such statements rest, we have no hesitation in referring him to Mr. Bovill's cross-examination of Mr. Hills himself.

High-Spouted Meters.—The wordy warfare now waging in Manchester with respect to the abuses alleged to be practised by means of high-spouted meters, has received a fresh impulse from the publication of an address to the Corporation of the city by Mr. Crosley, in vindication of himself from the charges brought against him by the Gas Committee, of improper interference with their administrative functions. This document gives a greater insight into the interior management of the Manchester Gas-Works than has been hitherto afforded to the public eye, and presents an unfavourable contrast with that of similar undertakings when carried on by private enterprise, controlled as such are by the possibility of competition. Under somewhat similar circumstances, the Lancaster Gas Company unhesitatingly pledged themselves to abandon the use of high-spouted meters, on their liability to be overfilled being pointed out to them. The Manager of the Manchester Gas-Works, on the contrary, is represented to have avowed his intention of recommending their use, even though the Gas Committee might have decided the reverse; and as the assertion has remained for several months without being publicly contradicted, we assume its accuracy is not questioned.

MODERNIZATION OF PLANT.

By H. C. Widlake, M.J.Inst.E., of the Plymouth and Stonehouse Gaslight and Coke Company.

(*Continued from p.* 173.)

It is now proposed to indicate in detail the manner in which the work of installing the additional motor and its control gear may be carried out without (excepting a final stage of about twelve hours' duration) interfering with the daily work of the machine—the necessary work being carried out in the intervals between the stoking rounds.

It is recommended that the work be carried out in the following stages:

Stage No. 1.—The machine to be kept in commission doing its ordinary routine duties; all work being carried out during the intervals between the rounds.

(A) Fit the change-over switch in a convenient position adjacent to the main controller.

(B) Instal a new run of 2-in. screwed cable conduit between the main controller and a change-over switch and the centre marked A on fig. 2 [*ante*, p. 173] about which the cable compensating gear swivels.

(C) Fit up radial type cable compensating gear between the inner and outer frames, for the purpose of compensating for the rise and fall of the inner frame.

Stage No. 2.—The machine to be kept in commission doing its ordinary routine duties; all work being carried out in the interval between the rounds.

(D) Construct wooden template of the sill-plate upon which it is proposed to mount the additional motor, and place thereon

the new motor and travel worm-box. All holding-down bolt holes to be marked-off and drilled on this wooden template, by means of which their position will be later on transferred to the sill-plate.

(F) Apply wooden template to the sill-plate, mark off the holding-down bolt-holes, and drill with ratchet gear.

(G) Fit travel motor on sill-plate and bolt-down.

(H) Run the necessary control cables between the travel motor and the control gear, and connect-up at each end. Placing the change-over switch in the travel position, try the travel motor in each direction, to make sure that all connections are correct. Afterwards place the change-over switch in the stoking position and carry on.

Stage No. 3.—The machine to be taken out of commission for about ten to twelve hours.

(I) Remove the vertical shaft and old travelling gear-box on the inner frame of the machine.

(J) Mount the new travel worm-box on the sill-plate, fit the new (the old one will act as a spare) bevel-wheel on the short vertical shaft which extends from the new worm-box through the sill-plate. This wheel is marked E on fig. 2.

Stage No. 1.

(A) The exact position of the change-over switch must depend to a certain extent upon the general arrangement on the inner frame; but fig. 2 shows the position selected by the writer upon the two machines under his care. A piece of ¼-in. plate was bolted against the frame at the back of the main controller and suitably stayed; and the change-over switch was bolted to it at such a height that the hand of the operator on the main controller handle clears the bottom of the change-over switch when the main controller handle is pushed over to the top notch.

(B) On fig. 2 is shown the run of the 2-in. screwed cable conduit carrying the four wires for the control of the new travel motor. An alternative route would be along the side of the near main channel upon which the main chain-wheel is mounted, and thence across to the point marked A on fig. 2. But this is a matter of choice, to be decided with due regard to the position of the existing fittings on the inner frame. A run of 1½-in. conduit would be of ample capacity for the four wires which will be used; but the larger size is recommended with a view to including in this run of conduit and the compensating gear (to be presently described) not only the four travel motor control cables, but also the main positive and negative feeders running from the two overhead collectors to the main switch on the inner frame. These two conductors will be at present run between the outer and the inner frames, *viâ* a somewhat clumsy twin flexible cable working over a pulley and counterweight compensating gear. At a later date, it will be found an advantage to include these two conductors in the new conduit system, for which a 2-in. diameter tube is accordingly recommended.

(C) Seeing that four wires have to be run between the fixed position outer frame and an inner frame having a vertical travel, it will be found that some form of cable compensating gear is necessary in order to compensate for this rise and fall of the inner frame. On most machines this compensating gear takes the form of a number of flexible cables working over pulleys in conjunction with counterweights; or, alternatively, a number of banjo wires are strained-up the outer frame in the vertical plane—a corresponding number of contact skates being fitted on the inner frame, in order to establish a sliding contact with these banjo wires.

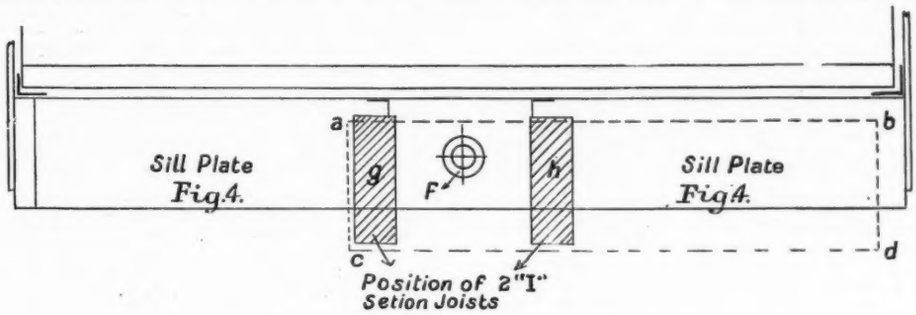
A newer type is known as the radial arm compensating system, which was designed by the writer and fully described in an article that appeared in the issue of the "Journal" for March 12. This type of gear possesses many advantages, besides being simpler and cheaper than those usually adopted. It is shown in detail in the article just mentioned and also in fig. 2 illustrating the present article.

This gear having been fitted, it will be as well to leave the conduits empty for the time, running the cables through them towards the end of the job just before the final break. But at this stage the gear should be watched closely, as the inner frame rises and falls, so as to make sure that it is working properly.

Stage No. 2—Illustrated by Figs. 4, 5, 6, and 7.

The general arrangement of the new travelling gear on the sill-plate will have been grasped by reference to fig. 2; and it will have been observed that the gear-box itself is mounted on a pair of I section joists *g* and *h* cut to the same length as the underside flange of the gear-box. The function of these joists is to raise the box to such a height as to permit of the spur-wheel on the end of the worm-shaft engaging with the pinion on the end of the motor shaft.

These pieces of I section joists are shown in figs. 2, 4, 5, and 6; and in all drawings are marked *g h*. Their top flanges are drilled for the reception of the gear-box; and six holes are drilled in the bottom flange of each piece for attachment to the sill-plate. The exact section to be used will depend upon the dimensions of the driving spur-gear between the gear-box and the motor, and upon the height of the centre line of the motor from the sill-plate. In the case of the conversions carried out by the writer, a 12-in. by 6-in. section was employed. The section having been decided upon by actual measurement, these two joists should now be cut to length; and six ¾-in. clear holes drilled in the bottom flange of each, as shown in fig. 5.



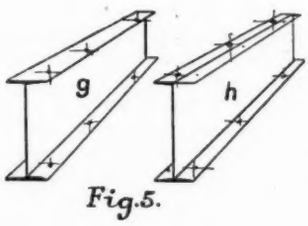


Fig.5.

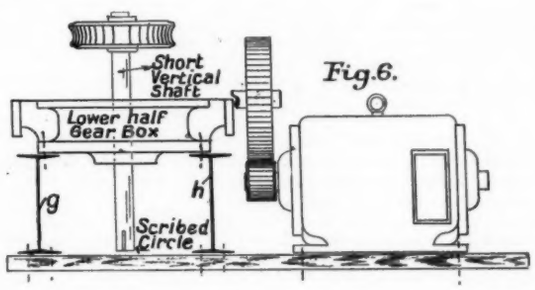


Fig.6.

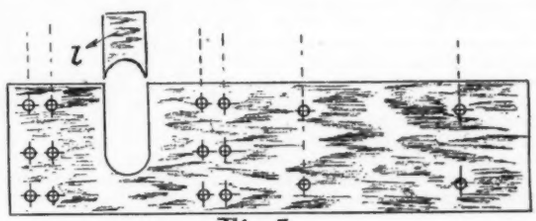


Fig.7.

The next essential is a well-planed wooden template, at least 1½ in. thick, and of the approximate dimensions shown by the dotted rectangle *a*, *b*, *c*, *d*, in fig. 4. These dimensions should be obtained by actual measurement of the sill-plate; and the template may now be laid on a level floor in the fitting shop, under suitable lifting tackle for the handling of the gear to be placed on it. Parallel guide-lines in both directions should be marked on the upper face of the template, and will be found to afford valuable assistance in the squaring-up of the gear-box and motor.

The gear-box should now be taken to pieces; and the top half, together with the worm-wheel shaft and worm-shaft, laid aside. The bottom half should be mounted squarely on the two joists *g* and *h*, as shown in figs. 5 and 6; and the position of the holes in the bottom flange of the box transmitted to the top flanges of these joists by means of a scriber. The holes so marked-out must be drilled, and the bottom portion of the gear box securely nutted-down to the two joists. After this the joists, with half of the gear-box attached, should be placed on one end of the wooden template and squared-off, as shown at the left-hand side of fig. 6. It will be found advantageous to drive some stout nails into the template round the edges of the bottom flanges of the joists, so as

to check any possible movement of this portion of the gear during subsequent handling.

The next step will be to locate upon the template the centre through which the short vertical shaft will pass. This may be done by slinging the shaft above the gear-box, and gently lowering it through the neck-bush in the bottom of the box, until its lower end rests on the wood template. A pencil line should be scribed round the shaft at this point; so that, when the shaft is lifted, a circle is left on the surface of the template. An alternative method for obtaining this centre is to use a plumb-line with a wooden register disc fitted into the bush at the bottom of the lower half of the gear-box. If the shaft itself is used for this purpose, it should be given a turn round, so as to ensure that it is free in the bush before the circle is marked out.

This circle having been located, the shaft should be lifted out, laid aside, and the worm shaft with its spur-wheel fitted securely into the bottom half of the gear-box, as shown also on the left-hand side of fig. 6. The motor may now be placed on the template, and lined-up in such a manner as to ensure its pinion meshing properly with the spur-wheel on the worm shaft as shown in fig. 6. In order to bring the spur wheel and pinion into mesh, it may be found necessary to insert two pieces of 2-in. wide packing under the feet of the motor, in which case these pieces must be nailed to the template before any marking-off is attempted, and must afterwards be duplicated in wrought iron for service on the finished installation.

The Complete Installation.

We now have the complete installation—motor, gear-box, and joists—all assembled on the template; and after making sure that everything is quite square and the gears properly in mesh, the positions of the holding-down bolts of both the motor and the two I section joists may be transferred to the template by means of a sharp-pointed pencil, after which the whole of the gear can be put aside and the bolt positions on the template centred and drilled.

As the template now appears (fig. 7), it will be remarked that there are four holes for the motor holding-down bolts and twelve holes for the attaching of the two joists on which the gear-box rests to the sill-plate. Between the positions occupied by these joists, there will be a circle representing the position occupied by the end of the vertical shaft. In view of the fact that, as the machine now stands, there is already a vertical shaft passing up through its sill-plate, it will be seen that as the template is at present it will be impossible to apply it to the sill-plate in the manner shown in fig. 4.

In order to permit of the template being applied to the sill-plate without interfering (for the present) with the existing long vertical shaft, a piece—*l*, fig. 7—will require to be cut out of the template. The width of the slot thus formed will be equal to the outside diameter of the existing bush through which the lower end of the vertical shaft passes, and which it will be seen (figs. 1 and 2) projects beyond the top of the sill-plate.

The template may now be applied to the sill-plate, set parallel with the edge of it, and the positions of the gear-box and motor holding-down bolts scribed on the top of the sill-plate, and the holes drilled with an engineer's ratchet drill and post.

The travelling motor may now be placed on the sill-plate, and securely bolted to it and four No. 7/16 S.W.G. rubber insulated cables run from it to the control-gear on the inner frame, *viâ* the compensating gear which has been installed for the reception of these cables—shown in fig. 2. Care should be taken to ensure that all four wires are of sufficient length to reach to the top terminal of the change-over switch. The next step is to connect the additional motor up to the control gear, and also to rearrange the connections of the existing motor on the inner frame of the machine, in order to permit of its operating through the change-over switch instead of (as before) direct from the main controller.

(To be continued.)

River Pollution by Tar-Distillation Plants.—Dr. Barwise, the Medical Officer of Health for Derbyshire, in his report for 1917, refers to the pollution caused by coke-ovens and coal-tar distillation plants. He says that, owing to the war, the number of coke-oven and tar-distillation plants for the making of benzol, sulphate of ammonia, and explosives has increased, and is still increasing. There are no wastes more difficult to treat than those from tar-distillation works and sulphate of ammonia plants. The result is that the rivers are now worse than they were before the war.

Industrial Coal Economy.—Addressing the Association of Engineers-in-Charge, Mr. David Wilson (the Technical Adviser to the Coal Controller) said that nobody should be allowed to use up one of the country's most valuable assets, unless he could show that it was being used efficiently. Even the electrical industry could do much more in this direction. Coal consumptions varied from 2 to 18 lbs. per unit; the thermal efficiency from 3 to 16 p.ct. If all coal used for steam raising was consumed upon scientific lines, the saving to the country would represent many millions of tons per annum. It was obviously to the advantage of the nation to consume as much coke as possible in lieu of coal; and the London County Council were now using considerable quantities of crushed coke on chain-grate mechanical stokers—both alone and mixed with coal on what was known as the "sandwich" system. A half-and-half mixture was possible without suffering any appreciable decrease in output.

MANCHESTER DISTRICT INSTITUTION OF GAS ENGINEERS.

Quarterly Meeting at Manchester.

The 182nd Quarterly Meeting of the Institution was held on Friday last, at the Grand Hotel, Manchester, under the presidency of Mr. J. P. Leather, of Burnley. The main feature of the proceedings—which were of a protracted character—was an extempore address on "Coal Conservation in Relation to Gas Manufacture," by Mr. Tim Duxbury, of Oldham; but this, with the report of the discussion which ensued, we are compelled to hold over until next week.

It was agreed that the minutes of the last quarterly meeting and of two special general meetings should be taken as read.

Members' Deaths.

The President said that, since their last meeting, they had lost two of their members—Mr. James Braddock, of Radcliffe, who was an original member of the Association, and one to whom they had looked for nearly half-a-century for help in many ways. He was not a man who made a great noise; but when he spoke they knew there was something wise in the counsel he gave. They all felt that a friend was gone in Mr. Braddock. Then they had lost Mr. Charles Harrison, of Accrington, who had been a member since 1897. He (the President) wrote in the name of the Institution to the relatives of both these gentlemen; and he now asked the members to confirm the vote of condolence by rising in their places. Another of their members—Mr. W. T. Buckland, of Chesterfield—had suffered a severe loss in the death of his wife; and he proposed a vote of condolence with Mr. Buckland.

The voting was accorded by the members rising in their places.

Apologies for Non-Attendance.

The Hon. Secretary (Mr. G. S. Frith, of Runcorn) announced that a number of letters had been received apologizing for non-attendance; these including communications from Mr. Samuel Glover, of St. Helens, and Mr. E. H. Hudson, of Normanton (the Senior Vice-President), who is suffering from influenza.

New Members.

The following new members were elected: Mr. William A Cartlidge, of Congleton; Mr. David Muir, of Tyldesley; and Mr. C. S. Shapley, of Leeds.

Office-Bearers.

Messrs. A. L. Jennings (Cleckheaton) and J. K. Law (Marple) were appointed Scrutineers of the ballot-papers, which showed that the following had been elected officers for the session 1919-20.

President.—Mr. A. E. Mottram, of Ossett.

Vice-Presidents.—Mr. E. H. Hudson, of Normanton, and Mr. Samuel Tagg, of Preston. [Owing to pressure of business, Mr. Hudson was unable to accept nomination as President, but consented to offer himself as Senior Vice-President for a further period of twelve months.]

Hon. Treasurer.—Mr. T. Banbury Ball, of Rochdale.

Hon. Secretary.—Mr. G. S. Frith, of Runcorn.

New Members of Committee.—Mr. R. H. Brown, of Birkenhead; Mr. Walter Hole, of Leeds; and Mr. W. J. Smith, of Bolton.

Auditors.—Mr. Charles Potts, of Hyde, and Mr. William Hill, of Stalybridge.

The Discussion.

The President, in calling upon Mr. Duxbury, said the subject they were to discuss was of the greatest importance at the present time. He had no doubt there were many in the room who were anxious about their coal supplies; and some of them, he felt sure, were anxious about the effect of the Household Fuel and Lighting Order. The whole question was not only a national one, but a matter of personal importance to many of them; and they were glad, therefore, of the opportunity of discussing the matter together.

BRITISH ASSOCIATION OF CHEMISTS.

A General Meeting of the British Association of Chemists was held in the College of Technology, Manchester, on Saturday afternoon, at which a large number of chemists were present from all parts of the country—representing technical chemists engaged in the various industries, and those in consulting and academic branches of the profession. After eight months of preliminary work had been done, it was resolved, at the general meeting in June last, to abandon the provisional form of the Society, and to proceed with the formation of the permanent Association.

At last Saturday's meeting, the Executive Committee presented draft regulations and a programme for approval. A report of the Nominations Committee, giving the degrees and other qualifications for membership, was also before the meeting. After some discussion and minor alterations, the various proposals were approved of; and it was decided to register the Association under the Companies Act.

INSTITUTION OF GAS ENGINEERS.

GAS INVESTIGATION COMMITTEE.

First Report, dated May 9, 1918, of the Research Sub-Committee appointed by the Gas Investigation Committee of the Institution, together with Supplementary Matter, Aug. 9, 1918.

The Gas Heating, Lighting, and Ventilation Research Committee of the Institution and the University of Leeds was in existence at the time of the appointment of the Gas Investigation Committee by the Institution, and was made the Research Sub-Committee "for the purpose of investigating the relative efficiency in use of different grades and compositions of gas," and reporting thereon to the Gas Investigation Committee. The composition of the Research Sub-Committee was:

Chairman.—Lt.-Col. Prof. Arthur Smithells, C.M.G., F.R.S.

Representatives of the University of Leeds.—Prof. J. B. Cohen, F.R.S., Prof. John W. Cobb, B.Sc., F.I.C., and Mr. G. R. Thompson, B.Sc.

Representatives of the Institution of Gas Engineers.—Messrs. John Bond, C.B.E., J. H. Brearley, E. W. Smith, D.Sc., F.I.C., and Charles Wood.

Mr. James W. Wood, M.Sc., A.I.C., was appointed Research Chemist for carrying out the work of the investigation under the supervision of the Livesey Professor, John W. Cobb.

INTRODUCTION.

A preliminary period was devoted to a critical examination of methods and instruments, with a view to securing reliability throughout, and saving time where possible. The experimental work was then transferred to the Nechells laboratory of the Birmingham Corporation Gas Department, where valuable facilities had been offered. It was there possible to carry out our intention of testing the relative merits of a number of gases and gas mixtures, which could be stored or mixed as desired in a graduated holder, and drawn straight into the laboratory for testing purposes.

We should like to acknowledge our indebtedness to the Birmingham Corporation Gas Department and to Mr. E. W. Smith, D.Sc., the Chief Chemist of the Department, and a member of our Committee.

Before presenting the details of our report, we should like to make some points perfectly clear. In the first place, we have not been concerned with comparative economics in producing gases by different methods, but in determining the relative efficiencies in use of the gases when made. These are two equally important, but distinct inquiries. Then, again, having regard to what is practicable—particularly at the present time and in the near future—our tests have all been made with what we regarded as good representative examples of existing appliances, and with no adjustments beyond those provided by the makers, unless otherwise stated. Our conclusions and recommendations are strictly limited by this consideration. The grades of gas investigated are such as are readily obtainable in gas-works practice.

In order to obtain useful information in a limited time, we have made a rapid survey of three important domestic applications of gas through the ring-burner, the incandescent mantle, and the gas-fire; but each section is necessarily incomplete, and requires further systematic investigation. It is to be noted that these three appliances—obviously depending as they do respectively upon total heat, total radiation, and limited (light) radiation—are well adapted for testing the ranges of usefulness which a gas possesses. Industrial heating and gas-engine work have not yet been touched; but valuable facilities have been offered to us.

Two brief interim reports have been presented to the Gas Investigation Committee; but these are not now given separately—the subject matter being incorporated below. We have tried to make the report as comprehensive as possible in the time available; but it is to be regarded as essentially of a preliminary character.

Finally, we should like to place on record our great appreciation of the patience, skill, and ingenuity which have been displayed throughout by Mr. James Wood, the Research Chemist, in carrying out this work at a time when exceptional difficulties have had to be constantly met and overcome.

PART I.

GAS-COOKERS, RING-BURNERS, AND SIMILAR APPLIANCES.

The immense number of low-pressure burners working upon the bunsen principle in gas-cookers and other appliances, renders some determination of the efficiency of various grades of gas when used with this type of apparatus essential. For this purpose, a simple water-boiling test was adopted, the details of which are as follows:

BOILING TEST.

The water is boiled in a copper kettle, clean and brightly polished, and of the shape and size shown in fig. 1. It is first counterpoised, and then filled with 8 lbs. of cold water. The choice of this quantity is quite arbitrary, but is convenient, and the same weight is used in all tests. The thermometer is placed with its bulb 1½ in. below the surface of the water, and slightly away from the vertical axis of the kettle. The ring-burner under test is mounted as nearly as possible as in an actual gas-cooker, and is fixed in position. The kettle can be supported upon stands at different heights above the burner, and makes contact with the stand at three points only. There is, therefore, no obstruction between the burner and the kettle. The distance H between the upper face of the burner and the base of the kettle is a most important detail of the test. There is no obstruction between the meter and the gas-nipple regulation effected before the meter, instead of by the cock against the nipple; and a gauge is provided, to indicate the pressure while the burner is in operation, as near to the nipple as is convenient. This pressure, which must be maintained at the nipple in order to work the burner under the stated conditions, is usually several tenths lower than the static pressure in the services from which the gas is being supplied.

In carrying out a test, the burner is first lighted, and adjusted to a suitable gas consumption and degree of aeration. The meter reading, temperature, and pressure are noted before and after each test; and from these data the gas consumption in cubic feet per hour, reduced to standard conditions, can be calculated in the ordinary way. The kettle containing 8 lbs. of cold water is placed in position, and the temperature of the water is read at intervals of one minute until quite close to the boiling point. A curve showing the relation between the time and the temperature is then plotted; and the exact time taken to pass from 60° to 212° Fahr. is noted. For this length of time the gas consumption is also calculated from the observed rate per hour. The following data are thus obtained:

W = weight of water in pounds (the water equivalent of the kettle and thermometer is not included).
C = gas consumption in c.ft. per hour at 60° Fahr. and 30 in. wet.
G = calorific value of the gas in B.Th.U. per c.ft. gross.
N = " " " " net.
T = time in minutes for the temperature to rise from 60° to 212° Fahr.

Then heat supplied by the gas while the water is being heated is:

$$\frac{T}{60} \times C \times G \text{ B.Th.U. gross} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and

$$\frac{T}{60} \times C \times N \text{ B.Th.U. net} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The heat, which is usefully received by and retained by the water, is:

$$\text{Weight of water} \times \text{rise in temperature} = W \text{ (60° to 212° Fahr.)} = 152 \times W \text{ B.Th.U.} \quad . \quad . \quad . \quad (3)$$

The efficiency is expressed in the ordinary engineering manner, viz.:

$$\text{Efficiency} = \frac{\text{Heat usefully retained by the water.}}{\text{Heat supplied by gas in same time.}}$$

And there may be two values, according to whether the gross or net calorific value of the gas be taken. Thus:

$$E_g = \frac{W \times 152 \times 60}{T \times C \times G} \times 100 \text{ p.ct. on gross calorific value} \quad . \quad (4)$$

and

$$E_n = \frac{W \times 152 \times 60}{T \times C \times N} \times 100 \text{ p.ct. on net calorific value} \quad . \quad (5)$$

When using 8 lbs. of water, equation (3) becomes $152 \times 8 = 1216$ B.Th.U. That is, 1216 B.Th.U. must be supplied in order to raise 8 lbs. of water from 60° to 212° Fahr.

The range taken, 60° to 212° Fahr., more nearly represents domestic practice than the usual range of 32° to 212° Fahr. If the latter value had been used, the efficiency figures would not have been affected in the slightest degree; but the time, gas consumption, and B.Th.U. gross and net, required would have been increased in the ratio:

$$\frac{32\text{-}212}{60\text{-}212} = \frac{450}{380} = \frac{1{\cdot}185}{1}$$

or 18·5 p.ct. increase in the values referred.*

Ring-Burners.—The ring-burners used for the tests were taken from actual gas cookers of recent date, and were selected as being typical burners, and fairly well proportioned to the kettle used.

Burner No. 1., Fig. 2.—The characteristic features of this burner are its long injector tube or mixing tube, and the fact that the gas jets are drilled at an angle to the face of the burner, thereby throwing the flames outwards, and behaving as what is

* It has been a custom for some writers in the Press to state their results as obtained with 1 quart = 2·5 lbs. water. For this reason extra columns have been added to the tables and obtained by simple arithmetical reduction in the ratio of 2·5/8 (0·312). They are given for purposes of comparison only, and with this reservation, that a one-quart vessel would have a smaller base; so that at some of the higher consumptions, more heat would be lost by flames forced beyond the sides of the smaller kettle. The efficiencies are, therefore, higher than those obtained by a kettle with a smaller base.

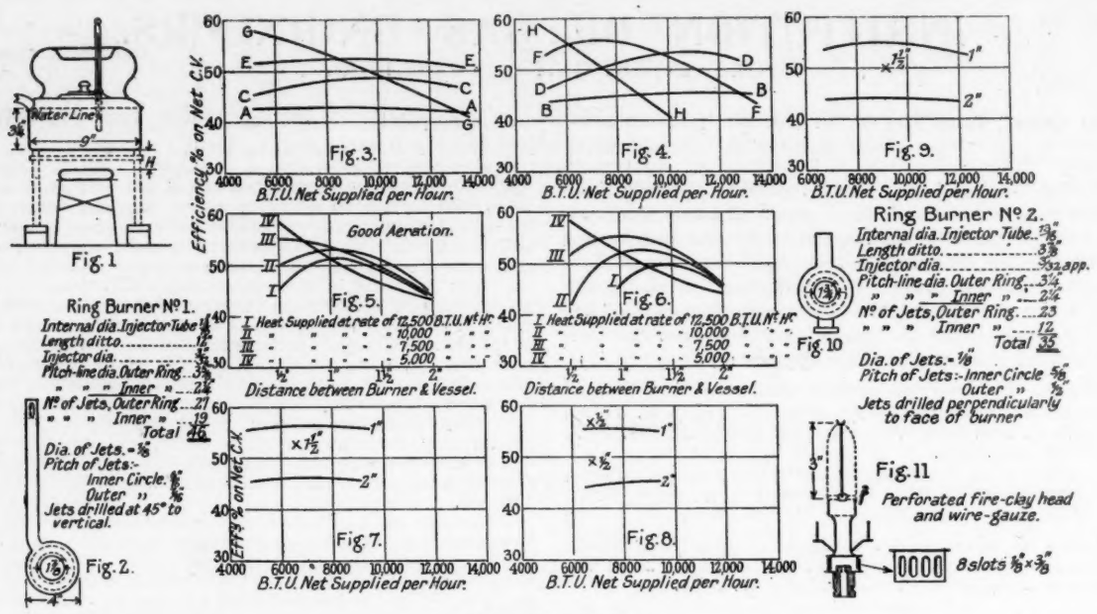


Fig. 1
Water Line
Fig. 2.
Ring Burner No 1.
Internal dia. Injector Tube 1"
Length ditto. 1"
Injector dia. 3/32"
Pitch-line dia. Outer Ring 3 3/4"
" " " Inner " 2 1/4"
No of Jets, Outer Ring 27
" " " Inner " 19
Total 46
Dia. of Jets = 1/8"
Pitch of Jets:-
Inner Circle. 5/8"
Outer " 7/8"
Jets drilled at 45° to vertical.
Efficiency % on Net C.V.
B.T.U. Net Supplied per Hour.
Fig. 3.
Fig. 4.
Fig. 9.
Good Aeration.
I Heat Supplied at rate of 12,500 B.T.U. Net Hr.
II " " " " 10,000 " "
III " " " " 7,500 " "
IV " " " " 5,000 " "
Distance between Burner & Vessel.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 10
Ring Burner No 2.
Internal dia. Injector Tube 13/64"
Length ditto. 3/8"
Injector dia. 3/32 app.
Pitch-line dia. Outer Ring 3 1/4"
" " " Inner " 2 1/4"
No of Jets, Outer Ring 23
" " " Inner " 12
Total 35
Dia. of Jets = 1/8"
Pitch of Jets:- Inner Circle 5/8"
Outer " 7/8"
Jets drilled perpendicularly to face of burner
Fig. 11
Perforated fire-clay head and wire-gauze.
8 slots 1/8" x 3/8"

DIAGRAMS—SHEET I.

virtually a large burner. The burner will not light-back with gases of a calorific value down to 400 B.Th.U. gross per c.ft.; but for dealing with poorer gases, an air-slide (not provided by the makers) was fitted for cutting-down the primary air. The flames are moderately well aerated, but not noisy; and while they carry less air than those of burner No. 2, it cannot be said that the burner suffers from undesirably poor aeration with any gas tried.

RING-BURNER TESTS, SERIES NO. 1.

This series of tests was carried out with the idea of determining the effect of using the same gas and the same burner, but varying the method of application. It is obvious that if the same burner will give widely different efficiencies under reasonable working conditions with the same gas, there will be difficulty in selecting values which shall be truly representative in comparing the behaviour of various gases. This section, therefore, possesses considerable value and importance, although really a side-issue to the main investigation.

The main factors which might influence the efficiency are: Gas quality, gas consumption, degree of aeration, and position of the kettle with regard to the flames. The results are, therefore, reported in sets, in each of which one factor only is intentionally varied. After each set, a brief comment is made where this seems advisable. For convenience in comparison, the figures are stated for equal increments of gas consumption corresponding to 5 c.ft. per hour of a gas of 500 B.Th.U. gross per c.ft.

Gas Used.—Coal gas of average quality.

Composition (Average).		Inert Constituents.		Calorific Value.
	P.Ct.		P.Ct.	
CO_2	3·7	CO_2	3·7	530 B.Th.U. gross per c.ft.
O_2	1·4	O_2	1·4	480 B.Th.U. net per c.ft.
*HC	3·2	N_2	13·6	at 60° Fahr. and 30 in. wet
CO	11·7			
H_2	40·5	Total	18 7	
CH_4	26·0			
N_2	13·6	CO_2	3·7	Ratio gross/net 1·103
	100 0	N_2	13·6	Sp.gr. ·519
			17·3	

* Unsaturated hydrocarbons.

Volume of air required per cubic foot of gas	4·4 c.ft.
Volume of self-combustible mixture per cubic foot of gas	5·4 c.ft.
B.Th.U. per cubic foot of self-combustible mixture	97 B.Th.U. gross
" " " "	87 B.Th.U. net
Volume of products of combustion per cubic foot of gas	5·2 c.ft.
B.Th.U. per cubic foot products of combustion	101 B.Th.U. gross
" " " "	91 B.Th.U. net
Ratio $CO_2 + N_2$ in original gas./total products of combustion	3·3 p.ct.

SET 2.

For numerical data see Table I. and Fig. 3, Curve A.

Kettle 2 in. above burner—*i.e.*, the normal distance in many gas cookers; flames well aerated.*

Test No. 12.—Flames well aerated; burner quiet; air-ports fully opened; maximum gas supply at available pressure; flames fairly large, but not touching kettle.

* In all cases the term "flame" refers to the visible flame.

Test No. 13.—As in No. 12, but flames shorter and well clear of kettle.

Test No. 14.—Similar to No. 13.

Test No. 15.—Flames about ½ in. long; type of flame that would be used for "simmering."

From the table and curves it will be noted that the efficiency is practically independent of consumption under the conditions indicated. As a matter of fact, the flames—even at the highest consumption—do not touch the bottom of the kettle; the heating being effected by hot air and hot "burnt-out" products of combustion. Merely as a matter of convenience, the higher gas rates would be used in practice to secure most rapid heating.

SET 3.

For numerical data see Table I. and Fig. 4, Curve B.

Kettle 2 in. above burner, as in Set 2; flames adjusted to have slightly luminous tips—*i.e.*, the primary aeration has been reduced.

Tests Nos. 19, 18, 17, 16.—Similar to corresponding tests in Set 2, but flames larger, paler, and not so "stiff." It will be noted that the results of this set of tests are rather higher than those of Set 2. One must take care, however, to ascribe the improvement to the proper cause. By reducing the aeration, the flames have been rendered larger, and (although probably cooler) are, therefore, nearer to the kettle. Hence the improved efficiency. The efficiency is but slightly affected by the rate of consumption; although the effect of the smaller flames at low consumption and loss of heat at higher consumptions, is quite noticeable. The variation is less than 1 p.ct. for any practical gas-rate.

SET 4.

For numerical data see Table I. and Fig. 3, Curve C.

Kettle 1½ in. above burner; fairly well aerated flames.

Tests Nos. 20, 21, 22, 23.—Flames have the same characteristics as corresponding values of Set 2; but tips of the flames are in each case nearer to kettle. When compared with Set 2, there is a notable improvement in the results, due to better flame-contact. The effect of the shorter flames at low consumptions is more marked. Maximum efficiency is obtained at about 19 to 20 c.ft. per hour. Excepting for very low consumptions, the efficiency is again independent of time or of consumption, within 1 p.ct.

SET 5.

For numerical data see Table I. and Fig. 4, Curve D.

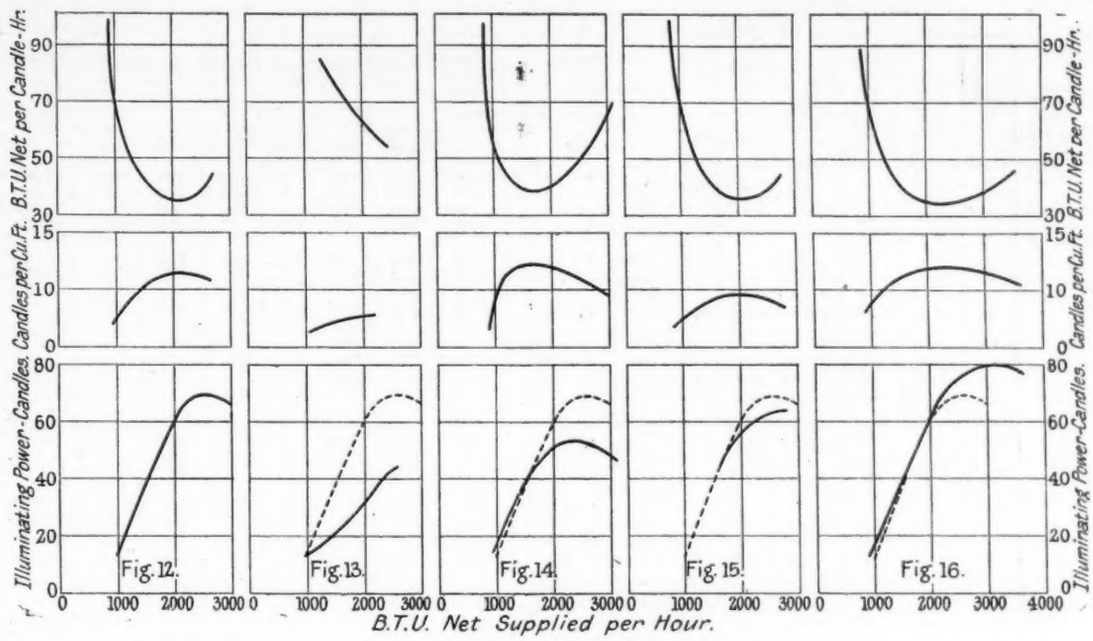
Kettle 1½ in. above burner, as in Set 4. Flames adjusted to have slightly luminous tips when burning freely. General characteristics of flames as in Set 3.

Tests Nos. 24, 25, 26, 27.—Similar to corresponding values of Set 3, but flames nearer to kettle. With this set of conditions the efficiency varies considerably with the gas consumption. The lower consumptions with short flames show little improvement upon Set 4. With medium consumptions the efficiency is higher, owing to better flame contact; while as the consumption increases the efficiency again falls off, owing to imperfect combustion and smothering of the flames by their own products of combustion, as well as by mutual interference. Such conditions would not be advisable in practice, in spite of the enhanced efficiency at certain consumptions.

SET 6.

For numerical data see Table I. and Fig. 3, Curve E.

Kettle 1 in. above face of burner; flames well aerated, and similar to those of Set 2.



DIAGRAMS—SHEET II.

Test No. 28.—Flames spread out by kettle, but not passing beyond edge of base.

Tests Nos. 29, 30, 31.—Satisfactory flame contact obtained at all consumptions.

With the kettle in this position, and with well-aerated flames, the results are markedly better than in Set 2; and there is very little variation in efficiency with consumption except beyond 20 c.ft. per hour, when the flames are somewhat distorted and smothered by their own products of combustion.

SET 7.

For numerical data see Table I. and Fig. 4, Curve F.

Kettle 1 in. above the face of the burner; flames adjusted to have slightly luminous tips when burning freely in air.

Test No. 32.—Flames more luminous when under kettle than when burning freely in air, due to defective aeration and ventilation; individual flames are indistinguishable; flames reach to the edge of kettle and just pass round sides; there is an objectionable odour, due to imperfect combustion.

Test No. 33.—As in No. 32, but characteristics less marked; objectionable odour still present.

Test No. 34.—Very slight odour.

Although there is a portion of the curve showing higher efficiency than the corresponding portion of Curve E, the efficiency falls off very rapidly on either side of the maximum. The objectionable odour would preclude a burner from being used in this manner, even with its high efficiency. The portion of the curve from 15 to 25 c.ft. per hour shows in an excellent manner the effects of poor ventilation and poor aeration.

SET 8.

For numerical data see Table I. and Fig. 3, Curve G.

Kettle ⅛ in. above face of burner; flames well aerated.

Test No. 36.—When kettle is placed in position flames become smothered with their own products of combustion; flames are driven downwards through the annulus of the burner; efficiency is low.

Test No. 37.—As in No. 36, but less marked.

Test No. 38.—Flames flattened-out by kettle.

Test No. 39.—Well-aerated flames; rather small; not interfered with by close proximity to the kettle; efficiency high.

The conditions of this test are abnormal as regards the distance between the burner and the kettle. In spite of the high efficiency of No. 39, the rapid falling off, due to bad ventilation, would make the use of a burner under these conditions impracticable.

SET 9.

For numerical data see Table I. and Fig. 4, Curve H.

Kettle ⅛ in. above the face of the burner, and flames adjusted to have luminous tips.

Tests Nos. 40, 41.—Similar to Nos. 36 and 37, but with objectionable odour.

The remarks made upon Set 8 apply with even greater force to Set 9. In figs. 5 and 6 precisely the same data are rearranged, to show more clearly the effect of keeping the gas consumption constant, but altering the position of the kettle with respect to the burner. It will be seen that each curve has a maximum value; and that for this particular burner a working distance of 1 to 1½ in. between the burner and the kettle gives the best all-round performance with the gas in use.

Summarizing.—The most satisfactory results (not necessarily the maximum results) obtained with this burner and this gas are:

Position.	Gas Consumption, C.Ft. per Hour.	Efficiency P.Ct. on	
		Gross C.V.	Net C.V.
Kettle 2 in. above burner .	12–24	39·4	43·5
,, 1 in. ,, ,, .	12–24	48·5	53·5

NOTE.—Above represents a variation in efficiency obtained of 10 p.ct. on 43 p.ct., or nearly 25 p.ct. difference in behaviour.

CONCLUSIONS.—RING-BURNERS.

(1) Within the limits examined, the efficiency does not depend upon the time taken to raise the temperature.

(2) Unless interfered with by very poor aeration or too close proximity of the containing vessel, the efficiency is almost independent of the rate at which the gas is burned between the limits 10 to 25 c.ft. per hour for this burner.

(3) Flame contact is essential for high efficiency, and should be made as complete as possible, consistent with proper aeration and ventilation of the burner.

(4) The distance of the bottom of the vessel from the burner requires careful consideration, in order to secure the maximum efficiency.

(5) Any factor—such as altering the composition or calorific value of the gas, or degree of aeration, or consumption—which alters the size and shape of the flames, is equivalent in effect to altering the distance between the bottom of the vessel and the burner.

(6) Poor aeration is not always a disadvantage from the thermal standpoint; but there is always risk of objection upon hygienic grounds.

The best working conditions for a burner of this type may be summarized thus: The burner should have fairly well-aerated flames, spaced sufficiently far apart to be separately visible when the burner is in use; and the best possible flame contact should be secured compatible with satisfactory aeration and ventilation of the flames.

In reviewing the results it is found that the variations in efficiency obtained when using the same gas under different conditions with this burner are greater than when using the same burner with widely different qualities of gas. This variation is also greater than the variation in efficiency with different patterns of burner.

Until some standard method of testing can be devised, therefore, it is advisable (when reporting results) to state in a precise manner the conditions under which the results were obtained. Many valuable data are otherwise greatly depreciated, and rendered useless as bases for calculation or design.

To treat several burners and a number of gases in this detail would be a stupendous task. By a judicious selection, therefore, an attempt has been made in further tests to arrive at a reasonable figure for the performance of the various gas mixtures which have been tried with this burner.

RING-BURNER TESTS, SERIES NO. 2.

This series of tests was carried out with gas of moderately low calorific value and high inerts. It was obtained by adding Mond

TABLE I.

Set.	Test No.	C.Ft. per Hour Supplied.	Equiv. C.Ft. per Hour of 500 B.Th.U. Gross.	B.Th.U. Gross per Hour Supplied.	B.Th.U. Net per Hour Supplied.	Efficiency Per Cent. on Gross C.V.	Efficiency Per Cent. on Net C.V.	Height of Kettle Base Above Burner. Inches.	Nipple Press. 1-10th Inch W.G.	Time in Mins. to Heat 8 Lbs. Water from 60-212° F.	8 Lbs. Water Heated 60-212° F. Required.			1 Quart Water Heated 60-212° F. Required.			Time in Mins. to Heat 1 Quart Water from 60-212° F.	
											B.Th.U. Gross.	B.Th.U. Net.	C. Ft. Gas.	B.Th.U. Gross.	B.Th.U. Net.	C. Ft. Gas.		
Set 2 .	12	23·44	25	12,500	11,250	39·2	43·2	2	28·4	15·0	3102	2815	5·86	980	886	1·83	4·7	Full
	13	18·75	20	10,000	9,000	39·5	43·6	2	18·3	18·6	3078	2789	5·81	966	879	1·82	5·8	aera-
	14	14·06	15	7,500	6,750	39·4	43·5	2	11·3	24·8	3086	2795	5·82	973	880	1·82	7·75	tion.
	15	9·37	10	5,000	4,500	39 2	43·2	2	5 6	37·5	3102	2815	5·86	980	886	1·83	11·7	
Set 3 .	19	23·44	25	12,500	11,250	41·2	45·5	2	28·4	14·3	2951	2672	5·57	931	841	1·74	4·5	Poor
	18	18·75	20	10,000	9,000	41·8	46·1	2	18·3	17·6	2909	2638	5·50	916	830	1·72	5·5	aera-
	17	14·06	15	7,500	6,750	41·2	45·5	2	11·3	23·8	2951	2672	5·57	931	841	1·74	7·4	tion.
	16	9·37	10	5,000	4,500	39·8	43·9	2	5·6	36·9	3055	2770	5·77	961	872	1·80	11·5	
Set 4 .	20	23·44	25	12,500	11,250	43·9	48·5	1½	28·4	13·4	2770	2507	5 23	872	790	1·63	4·2	Full
	21	18·75	20	10,000	9,000	45·0	49·7	1½	18·3	16·3	2703	2447	5·10	852	771	1·59	5·1	aera-
	23	14·06	15	7,500	6,750	44·0	48·6	1½	11·3	22·2	2764	2502	5·21	871	788	1·63	6·9	tion.
	22	9·37	10	5,000	4,500	41·9	46·2	1½	5·6	35·1	2902	2632	5·48	914	828	1·71	11·0	
Set 5 .	24	23·44	25	12,500	11,250	45·0	49·7	1½	28·4	13·1	2703	2447	5·10	851	772	1·59	4·1	Poor
	25	18·75	20	10,000	9,000	47·3	52·1	1½	18·3	15·6	2571	2334	4·86	810	734	1·52	4·9	aera-
	26	14·06	15	7,500	6,750	47·0	51·9	1½	11·3	20·8	2587	2343	4·88	815	739	1·52	6·5	tion.
	27	9·37	10	5,000	4,500	42·3	46·7	1½	5·6	34·8	2875	2604	5·34	904	821	1·70	10·8	
Set 6 .	28	23·44	25	12,500	11,250	47·2	52·0	1	28·4	12·5	2576	2338	4·87	810	787	1·52	3·9	Full
	29	18·75	20	10,000	9,000	48 3	53·3	1	18 3	15·2	2517	2281	4·75	792	718	1·48	4·3	aera-
	30	14·06	15	7,500	6,750	48·5	53·5	1	11·3	20·2	2507	2273	4·73	790	716	1·48	6·3	tion.
	31	9·37	10	5,000	4,500	47·2	52·0	1	5·6	31·2	2576	2338	4·87	810	787	1·52	9·7	
Set 7 .	32	23·44	25	12,500	11,250	41·8	46·1	1	28·4	14·1	2909	2638	5·50	916	829	1·72	4·4	Poor
	33	18·75	20	10,000	9,000	47·7	52·7	1	18·3	14·4	2550	2307	4·80	802	727	1·50	4·8	aera-
	34	14·06	15	7,500	6,750	50·2	55·4	1	11·3	19·5	2422	2195	4·58	712	692	1·43	6·1	tion.
	35	9·37	10	5,000	4,500	47·8	52·8	1	5 6	30·7	2544	2303	4·79	800	726	1·50	9·6	
Set 8 .	36	23·44	25	12,500	11,250	40·2	44·3	½	28·4	14·6	3025	2745	5·71	952	864	1·78	4·6	Full
	37	18·75	20	10,000	9,000	45·5	50·2	½	18·3	16·1	2672	2422	5·04	840	762	1·57	5·0	aera-
	38	14·06	15	7,500	6,750	49·7	54·9	½	11·3	19 7	2447	2215	4·62	771	697	1·44	6·1	tion.
	39	9·37	10	5,000	4,500	53·0	58·5	½	5·6	27·7	2295	2079	4·33	722	654	1·35	8·6	
Set 9 .	—	18·75	20	10,000	9,000	37·2	41·0	½	18·3	10·8	3269	2966	6·18	1028	934	1·93	6·2	Poor
	40	14·06	15	7,500	6,750	46·5	51·4	½	11·3	21·0	2615	2366	4·93	822	745	1·54	6·5	aera-
	41	9·37	10	5,000	4,500	53·0	58·5	½	5·6	27·7	2295	2079	4·33	722	654	1·35	9·0	tion-

* All gases are compared at equal rates of heat supply, and are stated at intervals, corresponding with 25, 20, 15, 10 c.ft. per hour for a gas of 500 B.Th.U. gross and 450 B.ThU. net per c.ft.

gas to a straight coal gas until the reduction in calorific value indicated in the following table was obtained. This method of securing the desired reduction is under better control for experimental purposes than actual "over-pulling;" but the effects upon the quantity of "inerts" in the gas is the same. No. 1 Ring-Burner was employed for the tests.

Type of Gas.—Moderately low calorific value and high inerts.

Composition.		Inert Constituents.		Calorific Value.
CO_2	6·9	CO_2	6·9	411 B.Th.U. gross per c.ft.
O_2	1·6	O_2	1·6	367 B.Th.U. net per c.ft.
HC	1·7	N_2	26·7	at 60° Fahr and 30 in. wet
CO	7·6			
H_2	35 1	Total	35 2	Ratio gross/net = 1·118
CH_4	20·4			
N_2	26·7			Sp. gr. ·608
	100·0			

Volume of air required per c.ft. gas	3·3 c.ft.	
Volume of self-combustible mixture per c.ft. gas	4·3 c.ft.	
B.Th.U. per c.ft. self-combustible mixture	95	B.Th.U. gross.
" " " "	85	B.Th.U. net.
Volume products of combustion per c.ft. gas	4·1 c.ft.	
B.Th.U. per c.ft. products combustion	100	B.Th.U. gross.
" " " "	90	B.Th.U. net.

Tests Nos. 42, 43.—Moderately well-aerated flames; air-ports nearly closed; burner will not light-back with air-ports fully open, but slightly more air would effect this; flames quite clear of kettle; kettle 2 in. above burner.

Tests Nos. 44, 45.—Similar to No. 42, but flames shorter; burner still fails to strike-back at lower consumption.

Test No. 46.—As in No. 44; kettle only 1½ in. above burner.

Tests Nos. 47, 48, 49.—Kettle 1 in. above burner.

The efficiency figures at equal rates of heat supply are slightly higher than those of Series 1; but the general arrangement of the curves on Fig. 7 is very much the same.

SERIES NO. 3.

This series of tests was carried out with a gas of moderately low calorific value (practically the same as for Series No. 2); but in this case the gas has been obtained by diluting a coal-gas with blue water-gas. The inerts, therefore, are lower than in Series No. 2. No. 1 Ring-Burner employed.

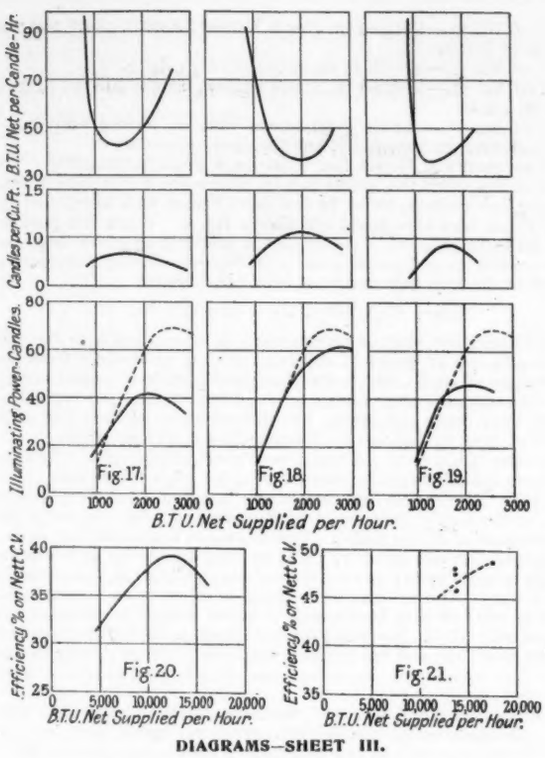
Type of Gas.—Coal-gas *plus* blue water-gas. 1 : 1.

Composition.	P.Ct.	Inert Constituents.	P.Ct.	Calorific Value
CO_2	5·1	CO_2	5·1	404 B.Th.U. gross per c.ft.
O_2	0·8	O_2	0·8	364 B.Th.U. net per c ft.
HC	1·5	N_2	20·1	at 60° Fahr. and 30 in. wet
CO	18·9			
H_2	39·5	Total	26 0	Ratio gross/net = 1·105
CH_4	14·1			
N_2	20·1			Sp. gr. ·584
	100·0			

Volume of air required per cubic foot gas	3·0 c.ft.	
Volume of self-combustible mixture per cubic foot gas	4·0 c.ft.	
B.Th.U. per cubic foot self-combustible mixture	100	B.Th.U. gross
" " " "	90	B.Th.U. net
Volume of products of combustion per cubic foot gas	3·8 c.ft.	
B.Th.U. per cubic foot products of combustion	107	B.Th.U. gross
" " " "	97	B.Th.U. net

TABLE II.—SEE ALSO FIG. 7.

Test No.	C.Ft. of Gas per Hour.	Equivalent C.Ft. Hour 500-450 Gas.	B.Th U. Net per Hour Supplied.	Efficiency P.Ct. on Net C.V.	H. Inches.	Required to Heat 8 Lbs. Water 60° to 212° Fahr				Required to Heat 1 Quart Water 60° to 212° Fahr.		
						Pressure 1 10th In.	B.Th.U. Net.	C.Ft. Gas.	Time, Mins.	B.Th.U. Net.	C.Ft.	Time, Mins.
42	24·35	20	9000	45·7	2	37½	2661	7·24	17·8	831	2·26	5·6
44	18 26	15	6750	45·7	2	21	2661	7·24	23·8	831	2·26	7·4
45	12·18	10	4500	45·2	2	11	2690	7·89	38·8	840	2·47	12·1
46	18 26	15	6750	53·0	1½	21	2294	6·24	20·5	716	1·95	6·4
47	24·35	20	9000	55·4	1	37½	2195	5·94	14·7	686	1·87	4·6
48	18·26	15	6750	56·2	1	21	2163	5·89	19·3	676	1·80	6·0
49	12·18	10	4500	55·3	1	11	2199	5·99	29·5	687	1·88	9·2



DIAGRAMS—SHEET III.

Tests Nos. 50, 51.—Flames well aerated; just short of lighting-back, with air-ports fully open; kettle 2 in. above burner.

Test No. 52.—Kettle 1½ in. above burner; flames rather short.

Tests Nos. 53, 54.—Kettle 1 in. above burner; good flame contact; very slight odour in No. 54.

Test No. 56.—Kettle ½ in. above burner; flames very much spread out and distorted; no luminosity (as evidence of defective aeration), but an objectionable odour present.

The results of this series are in agreement with those of Series No. 2, within the limits of experimental error, and the alteration in the composition of the gas has not affected the thermal efficiency in the slightest degree.

SERIES NO. 4.

In this series of tests a good straight coal-gas was mixed with air until the calorific value of the mixture was reduced to about 450 B.Th.U. gross per cubic foot. In the statements which follow the word "gas" refers to this air-gas mixture, as taken from the holder. "Original gas" is used for the gas before dilution with air. No. 1 Ring-Burner used for these tests.

Type of Gas.—Coal-gas *plus* air in ratio 4 : 1.

Composition.		Inert Constituents.		Calorific Value.
	P.Ct.		P.Ct.	
CO_2	3·6	CO_2	3·6	453 B.Th.U. gross per c.ft.
O_2	4·4	O_2	4·4	405 B.Th.U. net per c.ft.
HC	2·1	N_2	27·5	at 60° Fahr. and 30 in. wet
CO	7·5	Total	35·5	
H_2	32·9			Ratio gross/net = 1·118
CH_4	22·0			
N_2	27·5			Sp. gr. ·606
	100·0			

Volume of air (additional) required per cubic foot "gas"	3·4 c.ft.
Volume of self-combustible mixture per cubic foot "gas"	4·4 c.ft.
B.Th.U. per cubic foot self-combustible mixture	104 B.Th.U. gross
" " " "	93 B.Th.U. net
Volume of products of combustion per cubic foot "gas"	4·2 c.ft.
B.Th.U. per cubic foot products of combustion	109 B.Th.U. gross
" " " "	97 B.Th.U. net

With this air-gas mixture the burner can be made to light-back if the air-ports are fully opened—*i.e.*, if the burner is used just as it comes from the maker. In using the gas, however, the air-ports were adjusted to give what seemed to be normal aeration—*i.e.*, "stiff" flames with distinct inner cones, but not noisy. No. 1 Burner used for these tests.

Tests Nos. 57, 58, 59.—Kettle 2 in. above burner.

Test No. 60.—Kettle 1½ in. above burner; other conditions as before.

Tests Nos. 61, 62, 63.—Kettle 1 in. above burner; other conditions as before.

The set of results shown in Fig. 9 exhibits the same characteristics as the previous sets. The results are, if anything, slightly lower than the preceding—a feature which may be possibly explained by shortening of the flames on account of more rapid combustion, since the "gas" already carries part of the oxygen required for its combustion as it leaves the injector.

SERIES NO. 5.

It was thought that a more definite decision as to the effect of air added to the gas at the holder might be obtained if the process were carried a step further. In Series No. 5, therefore, the tests of Series No. 4 have been repeated, but with the addition of further air to reduce the calorific value of the "gas" to 350 B.Th.U. gross per cubic foot. It is found that with this "gas" there is trouble in reducing the aeration at the jets to a normal condition, even with the air-slide controlling the admission of primary air closed as completely as possible. The chief trouble with the gas is that of lighting-back.

TABLE III.—SEE FIG. 8.

							Required to Heat 8 lbs. Water 60° to 212° Fahr.			Required to Heat Quart Water 60° to 212° Fahr.		
Test No.	C.Ft. Gas per Hour.	Equivalent C.Ft Hour 520-450 Gas.	B.Th.U. Net per Hour Supplied.	Efficiency P.Ct. on Net C.V.	H. Inches.	Pressure 1-10th in.	B.Th.U. Net.	C.Ft. Gas.	Time, Mins.	B.Th.U. Net.	C.Ft.	Time, Mins.
50	24·76	20	9000	45·1	2	35	2696	7·40	17·9	841	2·31	5·6
51	18·57	15	6750	44·7	2	21	2720	7·47	24·2	849	2·33	7·6
52	18·57	15	6750	49 8	1½	21	2442	6·70	21·6	762	2·09	6·7
53	24·76	20	9000	55·3	1	35	2199	6·04	14·6	686	1·88	4·5
54	18·57	15	6750	55·8	1	21	2179	5·98	19·3	680	1·87	6 0
56	18·57	15	6750	56·5	½	21	2152	5·91	19·1	671	1·84	6 0

TABLE IV.—SEE ALSO FIG. 9.

							Required to Heat 8 lbs. Water, 60° to 212° Fahr.			Required to Heat 1 Quart Water, 60° to 212° Fahr.		
Test No.	Cubic feet Gas per Hour.	Equivalent Cubic Feet-Hour. 500-450 Gas.	B.Th.U. Net per Hour Supplied.	Efficiency per Cent. on Net C.V.	H. Inches.	Pressure. 1-10th in. W.G.	B.Th.U. Net.	Cubic Feet. Gas.	Time. Mins.	B.Th. U. Net.	Cubic Feet.	Time. Mins.
57	27·58	25	11,250	43·4	2	43	2802	6·91	15·0	876	2·16	4·7
58	22·07	20	9000	44·0	2	30	2763	6·82	18·6	862	2·13	5·8
59	16·55	15	6750	43·8	2	18	2776	6·85	24·8	868	2·14	7·8
60	22·07	20	9000	50·0	1½	30	2432	6·00	16·3	759	1·87	5·1
61	27·58	25	11,250	53·0	1	43	2294	5·66	12·3	717	1·76	3·8
62	22·07	20	9000	54·5	1	30	2231	5·50	14·9	696	1·72	4·7
63	16·55	15	6750	53·5	1	18	2273	5·61	20·4	711	1·75	6·4

Type of Gas. Straight coal gas *plus* air, in ratio 2 : 1.

Composition.	Inert Constituents.		Calorific Value.
		P.Ct.	
No complete analysis made.	CO_2	2·3	348 B.Th.U. gross per c.ft.
	O_2	7 9	314 B.Th.U. net per c.ft. at 60° Fahr. and 30in. wet
	N_2	40·8	
		51·0	Ratio $\frac{\text{Gross}}{\text{Net}}$ = 1·107.

Test No. 65.—Fairly well aerated; rather shorter flames than in No. 57; kettle 2 in. above burner.

Test No. 66.—Kettle 1½ in. above burner; flames well aerated, and not touching kettle.

Test No. 67.—Flames barely touching kettle; kettle 1 in. above burner.

Test No. 68.—As in No. 67; kettle ¾ in. above burner.

Test No. 69.—As in No. 68; kettle ½ in. above burner; better flame-contact, but slight interference of flames by products of combustion.

It would seem, at first sight, that the performance of this "gas" is distinctly inferior to any previously recorded. For corresponding positions of the kettle, this is undoubtedly true, and can be readily explained by the shorter flames with which this mixture burns. When carefully adjusted as regards distance from the burner, the maximum efficiency is the same as for the other gases, within the limits of experimental error.

Series No. 6.

Since the results hitherto obtained have not shown any marked differences, due to the presence of "inerts," it was decided to go beyond the limits of the original scheme, in order to obtain grossly exaggerated conditions. Mond gas was, therefore, used for the tests, slightly improved by the addition of a small amount of coal gas. The inerts are over 50 p.ct.; and the calorific value is unusually low. The character of the flame is entirely altered; being very short and pale blue in colour, instead of the usual purple of a well-aerated coal-gas flame. Burner No. 1 was used for the tests.

Type of Gas.—Low calorific value and very high inerts.

Composition.		Inert Constituents.		Calorific Value.
	P.Ct.		P.Ct.	
CO_2	13·3	CO_2	13·3	241 B.Th.U. gross per c.ft.
O_2	0·3	O_2	0·3	214 B.Th.U. net per c.ft. at 60 Fahr. and 30 in. wet.
HC	0·2	N_2	38·1	
CO	10·5	Total	51·7	Ratio gross/net, 1·125.
H_2	28 0			
CH_4	9·6			Sp. gr. ·750.
N_2	38·1			
	100·0			

Volume of air required per cubic foot of mixture	1·8 c.ft.
Volume of self-combustible mixture per cubic foot of gas	2·8 c.ft.
B.Th.U. per cubic foot of self-combustible mixture	84 B.Th.U. gross.
" " "	75 B.Th.U. net.
Volume of products of combustion per cubic foot of gas	2·7 c.ft.
B.Th.U. per cubic foot of products of combustion	90 B.Th.U. gross.
" " "	80 B.Th.U. net.

Test No. 70.—Kettle 2 in. above burner; flames short and well clear of kettle.

Test No. 71.—Kettle 1½ in. above burner; ditto.

Test No. 72.—Kettle 1 in. above burner; flames still too short to touch kettle.

Test No. 73.—Kettle ½ in. above burner; flames very much spread out; no luminosity, but objectionable odour

The results of Series No. 6 are in a sense remarkable. The efficiencies when the kettle is 2 in. above the burner are a little below the average, owing to the short flames with which this gas burns, as was also noted for Series No. 5. When the position of the kettle relative to the burner is properly adjusted, however, the results are quite consistent with those previously obtained, in spite of the high percentage of inert constituents.

Tests Repeated, with Burner No. 10.

Although the present investigation is concerned with the efficiency in use of gases of different quality, as distinct from the efficiency of appliances, it was thought desirable to repeat certain of the tests with other burners, in order to ensure that typical results were being obtained. For this purpose another burner of similar capacity but totally different design was obtained.

Burner No. 2 (Fig. 10) has a very short mixing tube. The gas jets are drilled vertically, instead of at an angle to the face of the burner. This means that flames of equal length will be relatively nearer the kettle than those of Burner No. 1 for nominally the same position of the kettle. The flames of the inner ring do not impinge upon one another. The spacing of the jets in the inner circle is more open; and the flames are opposite the spaces in the outer ring. The injector is designed to inject more air per cubic foot of gas; so that flames with a higher degree of aeration are obtained. All the foregoing features point to better aeration and better ventilation of the burner; and it was not surprising to find that the efficiency of this burner was greater than that of Burner No. 1.

The principal difficulty with the burner is the lighting-back with any gas much below 500 B.Th.U. gross per cubic foot; no air-slide being provided by the makers to cut down the primary air.

A number of tests have been carried out with this burner; but it is not considered necessary at this stage to publish them in detail. They bear very much the same relation to one another as those obtained with Burner No. 1—thus demonstrating that the results obtained with Burner No. 1 are quite satisfactory for comparative purposes.

The results obtained with Burner No. 2 are uniformly and consistently higher than those of No. 1 by about 6 p.ct.

Gas-Ovens.—No tests have been carried out with the ovens of gas-cookers. It is obvious that the temperature inside such ovens is far below the temperature of the gas-flames; and, since the temperature is obtained by mixing together the hot products of combustion with air in the oven, the attainable temperature is dependent only upon the amount of heat which can be supplied to the burners. Since the burners in such ovens are very similar in design to those of the gas-rings, similar conditions as regards gas pressure, &c., required for the delivery of the specified number of heat units per hour will apply in this case also.

Summary of Results.

Since the efficiency figures are not affected to any great extent by consumption, we have collected together in Table No. VII. a set of comparative figures representing the behaviour of the various gases we have tried at a consumption equivalent to 15 c.ft. per hour of a gas of 500 gross (250 net) B.Th.U. per cubic foot—*i.e.*, 6750 B.Th.U. net per hour. The best result with a

Table V.

Test No.	Cubic Feet Gas per Hour.	Equivalent Cubic Feet-Hour. 500-450 Gas.	B.Th.U. Net per Hour Supplied.	Efficiency per Cent. on Net C.V.	H. Inches.	Pressure. 1-10 in. W.G.	Required to Heat 8 lbs. Water, 60° to 212° Fahr. B.Th.U. Net.	Cubic Feet. Gas.	Time. Mins.	Required to Heat 1 Quart Water, 60° to 212° Fahr. B.Th.U. Net.	Cubic Feet.	Time. Mins.
65	21·56	15	6750	41·5	2	30	2930	9·33	26·0	914	2·91	8·1
66	21·56	15	6750	47·5	1½	30	2560	8·15	22·7	798	2·54	7·1
67	21·56	15	6750	51·1	1	30	2380	7·58	21·1	743	2·37	6·6
68	21·56	15	6750	54·6	¾	30	2227	7·09	19·7	696	2·22	6·1
69	21·56	15	6750	54·5	½	30	2231	7·10	19·8	698	2·22	6·2

Table VI.

Test No.	Cubic Feet Gas per Hour.	Equivalent Cubic Foot-Hour 500-450 Gas.	B.Th.U. Net per Hour Supplied.	Efficiency per Cent. on Net C.V.	H. Inches.	Pressure 1-10th in. W.G.	Required to Heat 8 lbs. Water, 60° to 212° Fahr. B.Th.U. Net.	Cubic Feet. Gas.	Time. Mins.	Required to Heat 1 Quart Water 60° to 212° Fahr. B.Th.U. Net.	Cubic Feet.	Time. Mins.
70	31·12	15	6750	41·6	2	56	2923	13·64	26·3	912	4·25	8·2
71	31·12	15	6750	49·6	1½	56	2452	11·44	22·1	767	3·57	6·9
72	31·12	15	6750	54·7	1	56	2223	10·37	20·0	693	3·23	6·2
73	31·12	15	6750	57·2	½	56	2126	9 12	19·1	663	3·10	6·0

properly adjusted burner has been selected in each case. While individual tests have shown higher efficiencies than these, they have been obtained under conditions which would not be suitable for general domestic use. The figures are arranged in the order of descending calorific value.

TABLE No. VII.

Series No.	C.V. Gross / Net.	Type of Gas.	Inerts. p. ct.	B.Th.U. Net per Hour.	C.Ft. Gas per Hour.	Effec. on Net C.V. P.Ct.	B.Th.U. Net to Boil 1 Qt.	H. In.	Pressure 1-10ths.
1	530 / 480	Coal gas	18·7	6750	14·06	53·5	710	1	11
4	453 / 405	Coal gas and air 4 : 1	35·5	6750	16·55	53·5	711	1	18
2	411 / 367	Coal gas H.inerts	35·2	6750	18·26	56·2	676	1	21
3	404	Coal gas + B.W.G.	26·1	6750	18·57	55·8	680	1	21
5	348 / 314	Coal gas + air 2/1	51·0	6750	21·56	54·6	696	3/4	30
6	241 / 214	Mond gas + Coal gas	51·7	6750	31·12	54·7	693	1	56

CONCLUSIONS WITH RESPECT TO RING-BURNERS.

(1) The conditions suitable for obtaining the highest efficiency (as already defined) from a particular burner have been stated in some detail.

(2) The results obtained from a particular gas depend upon the number of heat units supplied. Provided suitable adjustments are made, the efficiency is practically independent of composition, inerts, or calorific value. As a matter of practical convenience, to deliver a sufficient number of B.Th.U. in a reasonable time, without abnormal pressures, the gas used should be of moderately high calorific value.

(3) The conclusions outlined above depend presumably upon the fact that the difference between the temperature of the water (even at its boiling point) and that of the flames of any gas mixture which has been tried is so great that the variations in flame temperature met with in practice are negligible in effect.

(6) The addition of air to the gas at the holder (Series No. 5) does not give better results than those obtained with a properly adjusted burner working in the ordinary way; while the pressure, &c., required to deliver the same number of heat units and do the same heating is increased.

(7) The efficiency of ring-burners, properly adjusted and using the same gas, varies considerably with the type of burner employed.

(8) When the gas quality is sufficiently reduced, lighting-back occurs with most ring-burners in common use; but the limit varies considerably with the design of the burner. It varied from 500 B.Th.U. gross to 400 B.Th.U. gross in these experiments.

(9) A wide variation in grade or composition of gas can be made with reference to other uses. without impairing the efficiency of ring-burners now in use.

PART II.

LIGHTING WITH LOW-PRESSURE BURNERS.

The amount of gas used for lighting accounts for a considerable proportion of the gas supplied to domestic consumers, and the necessity for satisfactory lighting (both for domestic and public use) makes this section of the investigation extremely interesting and important.

Inasmuch as the light emitted from flames—whether they be self-luminous or applied to an incandescent mantle—is closely connected with the temperature attained by the luminous particles suspended therein, it was anticipated that the effects of varying the composition and calorific value of the gas would in such cases be more pronounced than in the case of the water-boiling test. How far these anticipations have been realized, and to what extent theoretical considerations have to be modified to allow for matters which at first sight appear to be of quite secondary importance, will very shortly be demonstrated.

FLAT-FLAME, SELF-LUMINOUS, OR "NAKED-LIGHT" BURNERS.

The literature upon the illuminating power of gas is very extensive, and many conflicting opinions have been put forward, especially with regard to the relation between illuminating power and calorific value. Upon certain points, however, opinion seems to be fairly well agreed; and they may be briefly summarized as follows.

To secure luminosity, it is necessary to have present gases—usually hydrocarbons—which will give rise to finite particles during their combustion. In addition, it is necessary to develop sufficient heat in the immediate vicinity of these particles to raise them to a sufficiently high temperature to give satisfactory illumination. It is immaterial whether such heat is derived from the hydrocarbons or from other constituents of the gas mixture, which of themselves possess little or no illuminating power. It, therefore, follows that similar illuminating powers could be attained in a variety of ways —*e.g.*, by small quantities of such particles intensely heated, or by larger quantities heated to a lower temperature. In short, there is no invariable relationship between the illuminating power and calorific value of gas mixtures burned in self-luminous flames.

It is well established that the addition of carbon dioxide and nitrogen to gases reduces their illuminating power to a far greater extent than would be expected from the reduction in calorific value alone.

There is a tendency in the gas industry to discourage the use of flat-flame burners as being out of date and uneconomical; and for this reason, and for those indicated above, we have deliberately refrained from making tests with flat-flame burners—the view being held that such tests would give results which it would be difficult to reconcile with one another, and would lead, moreover, to much useless controversy. Qualitative observations have, however, been made in a number of cases. For similar reasons, as well as from lack of time, no illuminating power tests have been made with the official argand burner. Attention has been paid only to the incandescent burner, the luminosity of which is generally supposed to be dependent only upon the amount of heat which can be imparted to the mantle, and the temperature which can be thereby realized. We place on one side for the moment the effect of varying the proportions of rare earths in the mantle itself, by which means the emissivity and illuminating power can be varied over a considerable range.

METHOD OE TESTING.

The method used for testing the illuminating power of the various gas mixtures is perfectly simple in principle. An upright incandescent burner of a good modern and widely used type was selected, with excellent provision for gas and air adjustment over a wide range—see fig 11. A number of mantles of similar size and shape, by the same maker and from the same batch, were obtained; but the same mantle was employed for as many tests as possible, in order to reduce discrepancies owing to a change of mantles. The difficulty of reproducing experimental conditions as regards the precise shape, position, and "balance" of the mantle is one of the most serious connected with this investigation. A 60-in. Letheby bar photometer was used for determining the illuminating power of the gas. As is the custom in official testing for illuminating power, the intensity of the light is measured in one direction only, in a horizontal plane through the centre of the mantle.

In testing, no standard consumption was maintained, as in official testing for the illuminating power of gas. Instead, a number of tests were made at successive consumptions, from values well below to values much above the normal gas consumption for the burner. When plotted on a curve, it is possible to see the variations in efficiency with consumption, and to a certain extent smooth-out errors in individual determinations. At each consumption the burner was adjusted to give its maximum illuminating power, by manipulating the air control.

It is worth mentioning at this point that in many cases—especially those in which the flame does not fit the mantle—there may be a choice of conditions. That is to say, the whole of the mantle may be fairly well illuminated or a smaller area of mantle may be intensely hot. In many cases there is no measurable difference in total candle power in the two conditions. In others, the smaller area, intensely heated, gives the higher total illumination—the improvement sometimes being over 10 p.ct.

The pressures quoted as "pressure at the burner" are the pressures observed between the regulating cock and the burner itself, and as close to the latter as possible. Although means of adjusting the gas pressure were provided on the burner body, this fitting was not used—full bore being allowed for all gases, after the main regulating cock.

Several unavoidable difficulties have been met with in carrying out these tests, the principal one of which has been the difficulty of reproducing standard conditions (referred to above) with, of course, the accepted difficulties of photometric testing, due to the difference in the colour of the light from the incandescent burner and that from the standard pentane lamp, aggravated in this case by the great difference in the illuminating power of the two sources, which may be in the ratio of seven or eight to one.

One point which is almost certain to be raised is that concerned with the possible deterioration of the mantle during tests. It may be stated that the whole of the tests have been carried out in a comparatively short time—certainly much shorter than the average effective life of the mantle. Further, after each batch of tests, a check has been made, and no deterioration of the mantle has been observed. As a further precaution, tests on gases of high and low calorific values have been made alternately; so that there can be no progressive error in favour of gases of either low or high calorific values. The results obtained may thus be considered as strictly comparable with one another; but, absolutely, they refer only to the burner used for the tests.

While actual experience shows that wide variations can be obtained with the same burner, there is every confidence in presenting the figures as representing normal and reasonable performance for the gases investigated when carefully and intelligently used. The fundamental data obtained are:

(1) The illuminating power in candles, measured as described above.

(2) The determined calorific value of the gas in B.Th.U. per cubic foot at 60° Fahr. and 30 in. wet, gross and net.
(3) The number of cubic feet of gas supplied per hour.

[In all cases the basis of comparison is the number of heat units supplied per hour.]

The results are reported in a uniform manner, and where two values are given, the lower refers to the net and the upper to the gross calorific value. The candle power per cubic foot of gas when burned at various rates has been calculated. It is difficult to express a figure for "efficiency" when the form in which the energy is supplied and that in which it is evolved are stated in different and totally unrelated units—in this case B.Th.U. on the one hand and candle power on the other. As a comparative figure, the B.Th.U. per candle-power-hour have been calculated—*i.e.*, the number of B.Th.U. which must be supplied in order to give illumination equivalent to 1 candle power maintained for one hour. The efficiency is greater in proportion as this number is reduced.

The results in the tables have been obtained by plotting the original data, and drawing curves through the points thus obtained. Values were then selected representing strictly comparable conditions, and are thus freed from the unavoidable irregularities of experimental work.

The results are reported in the order in which they were made.

Set No. 1.

The investigation was opened with a straight coal gas, subjected to some "pull," and further deteriorated by the fairly free use of air in the purifiers. It therefore represents a gas of moderate calorific value, and inerts which are approaching the limit of permissible (war-time) practice.

Table VIII.—See also Curve No. 12.

Composition.	P.Ct.	Inert Constituents.	P.Ct.	Calorific Value.
CO_2	3·7	CO_2	3·7	488 B.Th.U. gross per c.ft.
O_2	2·3	O_2	2·3	441 B.Th.U. net ,,
HC	2·6	N_2	20·4	at 60° Fahr. and 30 in. wet
CO	7·5	Total	26·4	
H_2	37·5			Ratio gross/net 1·108
CH_4	26·0	CO_2	3·7	
N_2	20·4	N_2	12·0	Sp. gr. ·546
	100·0		15·7	

Volume of air required per cubic foot gas	4·1 c.ft.
Volume of self-combustible mixture per cubic foot gas	5·1 c.ft.
B.Th.U. per cubic foot of self-combustible mixture	97 B.Th.U. gross
,, ,, ,, ,,	87 B.Th.U. net
Volume of products of combustion per cubic foot gas	49 c.ft.
B.Th.U. per cubic foot of products of combustion	100 B.Th.U. gross
,, ,, ,, ,,	91 B.Th.U. net.
Ratio $CO_2 + N_2$ in original gas/products of combustion	3·2 p.ct.

No.	B.Th.U. per Hour Supplied to Burner	Equiv. C.Ft. per Hour.	Illum. Power. Candles	Candles per C.Ft.	B.Th.U. per Candle Hour.	Pressure at Burner Tenths.	Notes.
1	1000 903	2·05	8·4	4·1	119·0 107·0	5 =	½ mantle heated.
2	1500 1354	3·05	29·6	9·6	50·7 45·8	11	¾ mantle heated.
3	2000 1805	4·09	50·7	12·4	39·6 35·7	17·5	¾ mantle heated air ports half open.
4	2500 2257	5·12	66·7	13·0	37·5 33·8	25	Mantle fully heated.
5	3000 2708	6·14	69·3	11·3	49·0 44·2	36·5	Fully heated, but brilliancy seems reduced.
*6	2900 2618	5·94	69·3	11·7	48·9 44·1	34	Maximum illumination.
*7	2300 2076	4·71	63·0	13·0	36·6 33·0	22	Most effective conversion of heat into light.

* A batswing burner will give quite a satisfactory light with this gas.

The gas gives satisfactory results, and is quite easy to regulate. It can be made to light-back on any but the highest consumptions; so that there is no question of deficient aeration. The flame can be adjusted (by varying the aeration) to fit the mantle over a wide range of consumption, although the fully-aerated flames appear to be rather small for the mantle employed. The candle-power curve is straight for a considerable distance; the illuminating power being roughly proportional to the heat supplied. As in Set No. 3, a maximum is obtained upon the candle-power curve; and the maximum illumination and the most economical production of light are not coincident. The duty obtained is rather better than with the gas of 600 B.Th.U. gross [see Set No. 3], while the maximum attainable candle power is considerably augmented. While such a gas would give satisfaction, it is believed that one of slightly higher calorific value would give better results. [See Set No. 6.] It should be noted that the efficiency expressed, say, by candles per foot, does not vary greatly over a fairly wide range (from 3 to 6 c.ft. per hour)—a very desirable feature in a domestic appliance.

Set No. 2.

The gas dealt with in this set of tests is one of low calorific value and high inerts. It was obtained by diluting a good straight coal gas with sufficient Mond gas to reduce its calorific value to the extent indicated. This method of obtaining the desired reduction was under better control for experimental purposes than heavy "over-pulling." The gas represents one of the outside limits attained in the investigation of the poorer gases. It can be seen from the composition that the gas is typical of a very much "over-pulled" gas.

Table No. IX.—See also Curve No. 13.

Type of Gas.—Very low calorific value due to high inerts.

Composition.	P. Ct.	Inert Constituents.	P.Ct.	Calorific Value.
CO_2	9·5	CO_2	9·5	368 B.Th.U. per c.ft. gross
O_2	0·9	O_2	0·9	330 B.Th.U. ,, net
HC	1·8	N_2	28·4	at 60° Fahr. and 30 in. wet
CO	8·4			
H_2	34·1	Total	38·8	
CH_4	16·9			
N_2	28·4			Ratio gross/net = 1·115
		CO_2	9·5	
	100·0	N_2	28·4	Sp. gr. ·645
			37·9	

Volume of air required per cubic foot of gas	3·0 c.ft.
Volume of self-combustible mixture per cubic foot of gas	4·0 c.ft.
B.Th.U. per cubic foot of self-combustible mixture	92 B.Th.U. gross.
,, ,, ,, ,,	82 B.Th.U. net.
Volume of products of combustion per cubic foot of gas	3·8 c.ft.
B.Th.U. per cubic foot products of combustion	97 B.Th.U. gross.
,, ,, ,, ,,	87 B.Th.U. net.
Ratio $CO_2 + N_2$ in original gas/total products of combustion	10 p.ct.

No.	B.Th.U. per Hour Supplied to Burner.	Equiv. C.ft. Gas per Hour.	Illum. Power, Candles.	Candles per C.Ft.	B.Th.U. per Candle Hour.	Pressure at Burner, 1-10 in.	Notes.
1	1000 897	2·72	7·6	2·8	132·0 118·4	8	½ mantle heated
2	1500 1345	4·07	17·0	4·2	88·0 78·9	18	¾ heated, brilliancy not very good
3	2000 1794	5·43	27·4	5·1	73·0 65·5	27	¾ mantle heated
4	2500 2242	6·79	39·3	5·8	64·0 57·4	43	Fully heated Brilliancy very inferior, with fullest air supply short of striking back

With a batswing burner this gas gives very inferior results, but might be sufficient to just "show a light."

In actual use this gas is troublesome, and lights-back with the slightest mis-adjustment of the air-slide. Apart from distribution difficulties, the efficiency obtained is very low; while the actual lighting obtained is well below what one normally expects from a burner of this type, and would be unsatisfactory in use.

As the above figures represent one of the boundaries of the investigation, it will pay to compare them carefully with those of Set No. 1. The calorific value is low; but the gas only requires three-quarters as much air for complete combustion as that of Set No. 1. The result is that the B.Th.U. per cubic foot of self-combustible mixture differ by less than 5 p.ct., and the B.Th.U. per cubic foot of products of combustion (which certain investigators would have us take as a rough measure of the calorific intensity) differ by only 3 p.ct. in the two cases. How, then is the falling off in efficiency to be explained when the heat is being supplied to the burner under what appear to be, upon theoretical grounds, very similar conditions?

One might be tempted to put down the results as due to the inerts present. The inerts in the original gas contribute only 10 p.ct. (as against 3 p.ct. in Set No. 1) to the products of combustion, and, moreover, the B.Th.U. per cubic foot of products of combustion is substantially the same in both cases; so that any view based upon cooling, dilution, or lowering of flame temperature becomes untenable—the alleged cause and effect being disproportionate.

Another explanation which may be suggestive is as follows: The gas of Set No. 2 requires less air per cubic foot than that of

Set No. 1 for perfect combustion. The former gas has the higher specific gravity; and, in delivering the same number of B.Th.U. per hour, it issues from the injector with a greater velocity, for the simple reason that a larger volume of gas must be delivered, on account of the reduced calorific value. The result is that the poorer gas per cubic foot may draw in as much air as, or more than, the richer one; and in any case the amount of air injected relative to the requirements of the gas will be much higher. In other words, an exceptionally well-aerated flame is produced, in which combustion is rapid and complete, as evinced by the ease with which the burner will light-back.

Under these conditions, it is conceivable that the gas would be almost completely burned before reaching the mantle, which would certainly not give the same high efficiency as if the mantle were placed in a zone of active combustion.

To the suggestion that this could be remedied by cutting-out all primary air, it may be stated that the air-ports of the burner cannot be closed with absolute air-tightness; and that in any case the exact size and shape of the zone of active combustion is a condition over which we have relatively little control in the case of the poorer gases. It would seem, therefore, in this—and in other cases, too—that complete aeration and rapid combustion are not always an advantage, or even desirable.

But whatever may be the explanation, the fact of importance to the gas engineer, and to the gas industry, is that a gas of this description with low calorific value and high inerts gives very inferior results with existing burners in whatever manner they may be adjusted.

The difficulties of manufacture, purification, and distribution of such a gas on a B.Th.U. basis would be immense; but such matters are outside the sphere of the present investigation.

From observation of the shapes and sizes of the flames, it is not considered that this gas would give normal results even with modified burners or mantles.

SET NO. 3.

The gas employed for this set of tests represents the richest gas employed in the lighting section of investigation.

TABLE X.

Type of Gas. Straight coal gas "A."

Composition.	P.Ct.	Inert Constituents.	P.Ct.	Calorific Value.
CO_2	2·7	CO_2	2·7	615 B.Th.U. gross per c.ft.
O_2	0·3	O_2	0·3	552 B.Th.U. net c.ft.
HC	3·4	N_2	7·1	At 60° Fahr. and 30-in wet.
CO	7·1			
H_2	46·0	Total	10·1	Ratio gross/net = 1·115.
CH_4	33·4			
N_2	7·1	CO_2	2·7	Sp. gr. ·430.
		N_2	7·1	
	100·0		9·8	

Volume of air required per c.ft. gas	5·2 c.ft.
Volume self-combustible mixture per c.ft gas	6·2 c.ft.
B.Th.U. per c.ft. self-combustible mixture	99 B.Th.U. gross.
" " " "	88 B.Th.U. net.
Volume products combustion per c.ft. gas	6·0 c.ft.
B.Th.U. per c.ft. products combustion	102 B.Th.U. gross.
" " "	92 B.Th.U. net.
Ratio " $CO_2 + N_2$ in original gas/total products combustion	1·6 p.ct.

No.	B.Th.U. Supplied to Burner per Hour.	Equiv. C.Ft. of Gas.	I.P. Candles.	Candles per C.Ft.	B.Th.U. per Candle Hour.	Pressure at Burner 1-10th in.	Notes.
1	1000 897	1·63	7·5	4·6	133·0 119·3	5	½ mantle heated.
2	1500 1345	2·44	35·0	14·3	43·0 38·6	7	⅔ mantle heated. Air ports well open.
3	2000 1794	3·25	47·3	14·55	42·3 37·9	10	As No. 2.
4	2500 2242	4·06	53·0	13·1	47·2 42·3	13	As No. 2, brilliancy increased.
5	3000 2690	4·88	52·1	10·7	61·5 55·1	17	Whole mantle heated. Air ports fully open.
6	3500 3139	5·69	45·0	7 9	78 0 70·0	22	Brilliancy not good. Visible flame outside and through top of mantle.
*7	2750 2466	4·47	53·5	12·0	51·4 46·1	15	Maximum illumination.
*8	1800 1614	2·93	43·4	14·8	40·0 35·9	9	Most economical production of light.

* Excellent light with batswing burner.

The gas used in this set of tests was easy to regulate; and there was no tendency to light-back at any consumption. The regularity of the points on the curve testifies to this ease of regulation. Upon the basis of either B.Th.U. per cubic foot of self-combustible mixture, or B.Th.U. per cubic foot of products of combustion, the gas is slightly, but appreciably, better than those of Sets Nos. 1 and 2.

The characteristic feature of the results is a well-marked maximum on the candle-power curve. Another characteristic is the steepness of the initial portion of the curve; the flame filling the mantle, and giving a good efficiency at low consumptions.

It is interesting to note that the most economical production of light is attained with this gas at about 3 c.ft. per hour (43 candle power), though the maximum illumination is obtained at 4·5 c.ft. per hour (53·5 candle power). The explanation of the inferior behaviour of this gas compared with one of about 500 B.Th.U. gross per cubic foot burnt is perfectly evident. The low specific gravity, low consumption, relatively low velocity of efflux from the injector and the high air requirements, combined with the fact that the flame very early fills the mantle, and that the air-ports must be fully opened, all point, without doubt, to insufficient aeration; and the shape of the curve confirms this view. The gas is too rich for the present burners, and could with advantage be diluted.

Several independent observers, in the Press and elsewhere, have noticed an improvement in the behaviour of the burners where the quality of the gas (formerly about 600 B.Th.U. gross) has been reduced to the present Government standard. To what extent the dilution should be practised is open to question; but the tests, so far as they have gone, point to a reduction below 500 B.Th.U. gross as inadvisable for the best efficiency. Whether this can be done to the best advantage with blue-water gas, air, or by over-pulling, awaits experimental trial. With 600 B.Th.U. gross gas there is no difficulty in supplying the necessary number of B.Th.U. per hour; and the consumer could readily obtain the maximum illuminating power indicated in the table with an available pressure of 15-10ths.

SET NO. 4.

Gas of 488 B.Th.U. gross, with a fairly high percentage of inert constituents. The results are combined with those of Set No. 1.

SET NO. 5.

The gas remaining in the holder at the end of Set No. 4 was diluted with air, to reduce the calorific value of the mixture to about 370 B.Th.U. gross per cubic foot. In what follows, the term "gas" will apply to this mixture; "original gas" being used for the gas before admixture with air in the holder.

TABLE XI.—SEE ALSO CURVE NO. 15.

Type of Gas.—Low calorific value and high inerts; the inerts being in the form of added air, to the extent of 30 p.ct. of the original gas, or 23 p.ct. of the mixture.

Composition.	P.ct.	Inert Constituents.	P.Ct.	Calorific Value.
CO_2	2·8	CO_2	2·8	373 B.Th.U. gross per c.ft.
O_2	6·5	O_2	6·5	335 B.Th.U. net " "
HC	2·0	N_2	34·5	at 60° Fahr., 30 in. wet.
CO	5·7			
H_2	28·7	Total	43·8	Ratio gross/net, 1·114.
CH_4	19·8			
N_2	34·5			Sp, gr. ·653.
	100·0			

Volume of air (additional) required per cubic foot of "gas"	2·9 c.ft.
Volume of self-combustible mixture per cubic foot of "gas"	3·9 c.ft.
*B.Th.U. per cubic foot self-combustible mixture	96 B.Th.U. gross
* " " " "	86 B.Th.U. net
Volume of products of combustion per cubic foot of "gas"	3·7 c.ft.
*B.Th.U. per cubic foot products of combustion	100 B.Th.U. gross
" " " "	90 B.Th.U. net

* Identical with Set No. 1 within limits of experimental error.

No.	B.Th.U. per Hour Supplied to Burner	Equiv. C.Ft. Gas.	I.P. Candles.	Candles per C.Ft.	B.Th.U. per Candle Hour.	Pres. at Burner 1-10th In.	Notes.
1	1000 898	2·68	9·1	3·4	110·0 98·7	8·7	½ mantle heated. Primary air entirely cut off.
2	1500 1346	4·02	29·4	7·3	51·0 45·8	17	⅔ mantle heated.
3	2000 1796	5·36	49·0	9·15	40·9 36·7	29	⅔ mantle heated. Noisy. Air ports nearly closed.
4	2500 2244	6·70	61·7	9·2	40·6 36·4	44	⅔ mantle heated. Air ports almost closed.
5	3000 2693	8·04	64·0	8·0	46·9 44·1	62	⅔ mantle heated.
*6	2900 2603	7·78	64·0	8·2	45·3 40·7	58	Maximum illumination.
*7	2300 2065	6·17	58·2	9·4	39·6 35·5	38	Most economical illumination.

* The gas is practically useless even for "showing a light" when used with a batswing burner.

This gas mixture is the most troublesome yet encountered, so far as both regulation and lighting-back are concerned; the trouble being even more pronounced than with the poor gas of Set No. 2, or with blue-water gas. The slam of a door, or the shriek of a whistle, will sometimes cause the burner to light-back.

A noteworthy feature of the results is that the gas does not behave as a poor gas, but (with the exception of one point to be noted later) gives exactly the same performance on B.Th.U. supplied to the burner as would an equivalent volume of the undiluted or original gas.

It is difficult to perceive what advantage is to be gained by mixing air with the gas, which, as we have already demonstrated [Set No. 1], can by itself, and undiluted, secure adequate aeration with the burner in use, or in what manner such a gas can differ from one burning with an equal amount of air self-injected at the burner base. It has been claimed that, on account of the more perfect mixture of air and gas, better combustion is ensured, and higher flame temperature can be reached—thereby giving better illumination. The actual tests show, however, that the results are identical with those of the original gas (based upon B.Th.U. supplied, and not upon cubic feet), both as regards illumination and duty, except at the higher consumptions, when the illumination is actually reduced. The flame appears to be too small for the mantle.

A similar explanation can be put forward to that suggested for Set No. 2—viz., that the combustion is rapid, that the flame may even be hotter, but that the mantle is not in the zone of active combustion, nor can it be placed there by any manipulation of the burner (*i.e.*, by varying either consumption or aeration). Illumination, therefore, falls off.

High pressures must be used to deliver the required heat units, both on account of the high specific gravity and low calorific value of the gas. With normal pressures and existing appliances, the attainable illumination would be far from satisfactory. Moreover, the gas would certainly not be fit to supply to the ordinary consumer, presumably with slight knowledge of gas manipulation.

While it is indicated above that the addition of air to a gas of 525 B.Th.U. gross (or below) is a distinct disadvantage, the statement would not apply to a gas of 600 B.Th.U. gross suffering from defective aeration. In that case, the addition of air would be corrective. The above results throw some light upon the much-disputed question as to the precise manner in which one should regard the carbon dioxide, oxygen, and nitrogen present in a gas mixture. Since none of these involves heat during combustion, it is perfectly right to term them all "inerts" when stating the calorific value of a gas or the volume of gas required to deliver a specified number of B.Th.U. On the other hand, the oxygen (together with an appropriate proportion of nitrogen) is an essential part of the mixture, which must be made before the heat units can be realized. It, therefore, follows that, unless the oxygen is present in any but small quantities—say, less than 1 p.ct.—the statement of the total inerts—including carbon dioxide, nitrogen, and oxygen—in the usual manner, gives an entirely misleading idea as to the properties and probable performance of the gas in practice.

Set No. 6.

The gas employed for these tests was a coal gas of average quality. Examination shows it to be of somewhat better quality than that of Set No. 1.

The gas of this set is interesting, because it lies between Set No. 1 and Set No. 2 (488 and 600 B.Th.U. gross respectively) as regards composition and calorific value. The curves for this gas and for that of Set No. 1 are practically coincident for the greater part of their length—thus demonstrating that, provided equal numbers of heat units be supplied to the burner in such a manner that they can be utilized by the mantle to the best advantage, the efficiency will be high, and will remain unaltered.

The remarks made with regard to Set No. 1 apply to this set; and, although the gas requires about 10 p.ct. more air, the burner is quite capable of supplying it, as the air-ports were not fully opened at the highest consumption.

It will be noted that the candle-power curve goes beyond that of Set No. 1; and this is of interest from the point of view of the investigation. It means, actually, that an enhanced illumination is obtained, because a greater number of heat units can be developed in contact with the mantle in a given time.

From the point of view of efficiency, as judged by B.Th.U. per candle-hour alone, there is nothing to choose between this gas of 525 B.Th.U. per cubic foot gross and that of 488 B.Th.U. gross; but under favourable circumstances a rather higher candle power can be developed with the richer gas.

The curves showing candles per cubic foot and B.Th.U. per candle-hour have a very much flattened maximum and minimum respectively, which means that the efficiency does not vary greatly over a considerable range of consumption—a most desirable feature in a gas intended for public supply.

With the exception of the air-gas mixture of Set No. 5, blue water-gas is the most difficult gas yet handled.

Although not suggested as a gas for public supply *per se*, it is suggested for admixture with coal gas to a considerable extent; and the fact that it is the gas most often quoted in discussions upon the theoretical aspect of heating and lighting with gases of low calorific values give it great interest, and the tests were made with this point in view.

Table XII.—See also Curve No. 16.

Type of Gas. Coal gas of average quality.

Composition		Inert Constituents.		Calorific Value.
	P.Ct.		P.Ct.	
CO_2	3·7	CO_2	3·7	525 B.Th.U. gross per c.ft.
O_2	1·4	O_2	1·4	472 B.Th.U. net " "
HO	3·2	N_2	13·6	at 60° Fahr., 30 in. wet
CO	11·7			
H_2	40·5	Total	18·7	
CH_4	26·0	CO_2	3·7	Ratio gross/net 1·111
N_2	13·6	N_2	13·6	
	100·1		17·3	Sp. Gr. ·519

Volume of air required per cubic foot gas	4·4 c.ft.
Volume of self-combustible mixture per cubic foot gas	5·4 c.ft.
B.Th.U. per cubic foot self-combustible mixture	97 B.Th.U. gross
" " " "	87 B.Th.U. net
Volume of products of combustion per cubic foot gas	5·2 c.ft.
B.Th.U. per cubic foot products of combustion	101 B.Th.U. gross
" " " "	91 B.Th.U. net
Ratio CO_2+N_2 in original gas/total products of combustion	3·3 p.ct.

No.	B.Th.U. per Hour Supplied.	Equiv. C.Ft. Gas.	I.P. Candles.	Candles per C.Ft.	B.Th.U. per Candle Hour.	Pres. at Burner 1-10th In.	Notes.
1	1000 901	1·91	10·9	5·7	92·0 82·9	4·5	½ mantle heated. Primary air almost cut off.
2	1500 1351	2·86	31·0	10·8	48·5 43·7	8	¾ mantle heated. Not much aeration.
3	2000 1802	3·81	51·0	13·4	39·3 35·4	13	Practically heated to top.
4	2500 2252	4·77	68·4	14·3	36·6 33·0	19	As No. 3 air increased.
5	3000 2703	5·72	77·0	13·4	39·0 35·1	27	Ditto air increased.
6	3500 3153	6·67	80·0	12·0	43·8 39·5	36	Very brilliant, rather noisy.
7	4000 3604	7·63	78·8	10·3	50·8 45·1	52	Air-slide not quite fully opened.
*8	3600 3243	6·87	80·1	11·7	45·0 40·5	38	Maximum illumination.
*9	2500 2252	4·77	68·4	14·3	36·6 33·0	19	Most economical illumination.

* Excellent illumination with batswing burner.

From the point of view of efficiency, as judged by B.Th.U. per candle-hour alone, there is nothing to choose between this gas of 525 B.Th.U. per cubic foot gross and that of 488 B.Th.U. gross; but under favourable circumstances a rather higher candle power can be developed with the richer gas.

The curves showing candles per cubic foot and B.Th.U. per candle-hour have a very much flattened maximum and minimum respectively, which means that the efficiency does not vary greatly over a considerable range of consumption—a most desirable feature in a gas intended for public supply.

With the exception of the air-gas mixture of Set No. 5, blue water-gas is the most difficult gas yet handled.

Although not suggested as a gas for public supply *per se*, it is suggested for admixture with coal gas to a considerable extent; and the fact that it is the gas most often quoted in discussions upon the theoretical aspect of heating and lighting with gases of low calorific values give it great interest, and the tests were made with this point in view.

Set No. 7.

A glance at the upper part of Table No. XIII. shows that, although the calorific value is low, the air requirement of the gas is exceptionally low; so that the B.Th.U. per cubic foot of the mixture are substantially the same as for average coal gas. The B.Th.U. per cubic foot of the products of combustion are, however, fully 6 p.ct. higher than any other gas mixture we have tried; and it is upon this fact that most of the theoretical claims for the gas are based—in connection with furnace-work and similar applications. Actual trial shows that for very small consumptions (up to 1600 B.Th.U. gross, equal to 5 c.ft. per hour) the gas is certainly equal, if not a little superior, to coal gas of 500 B.Th.U. gross per cubic foot, when considered on a B.Th.U. basis only—thus confirming in some measure the theoretical claims advanced. Beyond 5 c.ft. per hour, the illuminating power and also the duty fall rapidly; certain peculiarities of the gas becoming very pronounced, and entirely reversing this favourable verdict.

The flame actually is too large for the mantle (it may be because aeration is insufficient); but if any attempt is made to reduce the size of the flame by increasing the aeration, the gas at once lights-back. This behaviour of the gas mixture precludes us from taking full advantage of the low air requirements and of the short, hot flame, which is usually considered to be characteristic of blue water-gas.

In this connection it is interesting to refer to the work of Mr. Forshaw, Research Fellow to the Institution, carried out some years ago upon the illuminating power of hydrogen and carbon monoxide (the two chief constituents of blue water-gas) and described before the Institution in 1909. His work emphasized the importance of aeration upon flame shape, and showed the characteristic shapes of hydrogen and carbon monoxide flames. Unfortunately, for comparison with the results of the present investigation, he used special burners; and the duty we have obtained with a commercial burner falls considerably short of 11 candles per cubic foot for hydrogen, and 17 candles per cubic foot for carbon monoxide obtained by that worker.

The duty given by this gas up to the point at which its peculiarities interfere is distinctly better than that of the gas of Set No. 2, of like calorific value, but exceptionally high percentage

TABLE XIII.—SEE ALSO CURVE No. 17.

Type of Gas. Blue water-gas with modern inerts.

Composition.		Inert Constituents.		Calorific Value.
	P.Ct.		P.Ct.	
CO_2	8·2	CO_2	8·2	314 B.Th.U. gross per c.ft.
O_2	0·9	O_2	0·9	285 B.Th.U. net ,, ,,
HO	0·7	N_2	9·9	at 60° Fahr. and 30 in. wet
CO	30·5			
H_2	46·3	Total	19·0	
CH_4	3·5			Ratio/gross net 1·103
N_2	9·9	CO_2	8·2	
		N_2	9·9	Sp. gr. ·635
	100·0		18·1	

Volume air required per cubic foot gas	2·3 c.ft.
Volume self-combustible mixture per cubic foot gas	3·3 c.ft.
B.Th.U. per cubic foot self-combustible mixture	95 B.Th.U. gross 86 B.Th.U. net
Volume products of combustion per cubic foot gas	2·9 c.ft.
B.Th.U. per cubic foot products of combustion	107 B.Th.U. gross 97 B.Th.U. net
Ratio $CO_2 + N_2$ in original gas/total products of combustion	6·2 p.ct.

No.	B.Th.U. Supplied per Hour.	Equiv. C.Ft. Hour.	I.P. Candles.	Candles per Foot.	B.Th.U. per Candle Hour.	Pres. at Burner 1-10th In	Notes.
1	1000 907	3·19	12·6	4·0	79·6 72·2	10·5	½ mantle heated, air-slide closed
2	1500 1360	4·78	31·7	6·6	47·4 43·0	22	¾ mantle heated, no primary air.
3	2000 1813	6·37	40·0	6·3	50 0 45·3	36	¾ mantle heated. Noisy. Brilliancy fairly good.
4	2500 2267	7·96	39·8	5·0	63·2 57·3	52	Flame rather too large for mantle, and any attempt to reduce size by increasing aeration causes back-firing.
5	3000 2720	9·56	35·5	3·7	84·6 76·7	71	
*6	2300	7·33	41·0	5·6	56·1	45	Maximum illumination.
*7	1700	5·42	36·9	6·8	46·1	27	Most economical illumination.

* Batswing burner gives a non-luminous flame with a very feeble yellow fringe, quite useless even for "showing a light."

of inerts. Apart from the usual objection on account of the high percentage of carbon monoxide present, the gas is quite unsuitable for public supply.

SET No. 8.

Carburetted water gas was tried, because in calorific value it is not far removed from the coal gas of Set No. 1, but is of totally different composition.

The gas gives a slightly higher duty than the coal gas up to a certain point, beyond which peculiarities, due to over-aeration (as in the case of blue water gas), become very pronounced. On this account, the maximum attainable illuminating power falls short of that of Set No. 1.

TABLE XIV.—SEE ALSO CURVE No. 18.

Type of Gas.—Semi-carburetted water gas.

Composition.		Inert Constituents.		Calorific Value.
	P.Ct.		P.Ct.	
CO_2	7·9	CO_2	7·9	446 B.Th.U. gross per c.ft.
O_2	0·9	O_2	0·9	409 B.Th.U. net ,, ,,
HC	5·8	N_2	15·8	at 60° Fahr., 30 in. wet
CO	23·4			
H_2	36·0	Total	24·6	Ratio gross/net, 1·092.
CH_4	10·2			
N_2	15·8	CO_2	7·9	Sp. gr., ·538.
		N_2	15·8	
	100·0		23·7	

Volume of air required per cubic foot of gas	3·7 c.ft.
Volume of self-combustible mixture per cubic foot of gas	4·7 c.ft.
B.Th.U. per cubic foot of self-combustible mixture	94 B.Th.U. gross. 86 B.Th.U. net.
Volume of products of combustion per cubic foot of gas	45 c.ft.
B.Th.U. per cubic foot of products of combustion	99 B.Th.U. gross. 91 B.Th.U. net.
Ratio $CO_2 + N_2$ in original gas/total products of combustion	8·6 p.ct.

No.	B.Th.U. Supplied per Hour.	Equiv. C.Ft.	I.P. Candles.	Candles per C.Ft.	B.Th.U. per Candle-Hour.	Pres. at Burner, 1-10th In.	Notes.
1	1000 916	2·24	10·5	4·7	95·4 87·4	6	½ mantle heated No primary air.
2	1500 1374	3·36	32·0	9·5	46·8 42·8	12	¾ mantle well heated.
3	2000 1832	4·48	50·5	11·2	39·6 36·3	21	Heated nearly to top.
4	2500 2290	5 60	58·6	10·5	42·7 39·1	33	Brilliancy fair. Noisy. Air-slide slightly opened.
5	3000 2478	6·73	61·0	9·05	49·2 45·1	48	Ditto. Very slight air adjustment causes back-firing.
*6	3000 2748	6·73	61·0	9·05	49·2 45·1	48	Maximum illumination.
*7	1900 1740	4·26	48·0	11·3	39·6 36·3	19	Most economical illumination.

* Quite satisfactory results with batswing burner.

SET No. 9.

The gas of this set of tests was not very difficult to handle. It is identical in its calorific value with that of Set No. 2; but the percentage of inerts is quite different in the two cases, and the candle-power curves are of totally different shape.

TABLE XV.—SEE ALSO CURVE No. 19.

Type of Gas.—Coal gas with very large proportion of blue water gas (1 : 2).

Composition.		Inert Constituents.		Calorific Value.
	P.Ct.		P.Ct.	
CO_2	6·6	CO_2	6·6	365 B.Th.U. gross per c.ft.
O_2	1·3	O_2	1·3	330 B.Th.U. net ,,
HC	1·2	N_2	12·3	at 60° Fahr. and 30 in. we
CO	24·3			
H_2	43·2	Total	20·2	
CH_4	11·0			Ratio gross/net, 1·105
N_2	12·3	CO_2	6·6	
		N_2	12·3	Sp. gr. ·572
	99·9		18·9	

Volume of air required per cubic foot gas	2·9 c.ft.
Volume of self-combustible mixture per cubic foot gas	3·9 c.ft.
B.Th.U. per cubic foot of self-combustible mixture	94 B.Th.U. gross 85 B.Th.U. net
Volume of products of combustion per cubic foot gas	3·5 c.ft.
B.Th.U. per cubic foot of products of combustion	103 B.Th.U. gross 93 B.Th.U. net
Ratio $CO_2 + N_2$ in original gas/total products of combustion	5·3 p.ct.

No.	B.Th.U. Supplied per Hour.	Equiv. C.Ft.	I.P. Candles.	Candles per C.Ft.	B.Th.U. per Candle Hour.	Pressure at Burner. C.Ft.	Notes.
1	1000 905	2·74	7·0	2·6	143·0 129·3	8	Practically no primary air, ½ mantle well heated
2	1500 1357	4 11	36·0	8·7	41·7 37·7	17	½ mantle heated
3	2000 1810	5·48	45·8	8·4	43·7 39 6	30	Whole mantle heated, air-slide barely opened
4	2500 2262	6·85	45·0	6·6	55·5 50·2	46	ditto
*5	2250 2036	6·16	46·0	7·5	48·9 44·3	37	Maximum illumination
*6	1650 1493	4·52	41·3	9·1	40·0 36·2	20	Most economical illumination

* Feeble light with batswing burner.

The results show, without doubt, that a gas of low calorific value and high inerts is more difficult to manipulate than, and does not give such good results as, a gas of low calorific value, but mainly of combustible matter. While this is probably also true over the greater part of the gas mixtures experimented with, the actual effects of the inerts in the case of gases of normal calorific value (from 500 to 550 B.Th.U. gross) are, in practice, so small as to be negligible.

TABLE No. XVI.—RESULTS ARRANGED IN ORDER OF DESCENDING CALORIFIC VALUE.

Set.	Calorific Value.	Type of Gas.	Total Inerts P.Ct.	Sp. Gr.	B.Th.U. Net per C.Ft.		Air Required per C.Ft. Gas.	Maximum I.P.					Most Efficient Production of Light.				
					Gas and Air Mixture.	Products Combustion.		I.P.	C.Ft. Gas, Hour.	Can. per C.Ft.	B.Th.U. Net per Candle.	Pres. 1-10th W. G.	I.P.	C.Ft.	Candles per C.Ft.	B.Th.U. Net per Candle	Pressure at Burner 1-10th in.
							C.Ft.										
Set 3 .	615	Coal gas "A"	10·1	·430	88·2	91·9	5·24	54	4·5	12·0	46	15	43	2 9	14·8	36	9
p.	552																
Set 6 .	525	Coal gas "B"	18·7	·519	87·2	91·1	4·41	80	6·9	11·7	41	38	68	4·2	14·3	33	19
p.	472																
Set 1 .	488	Coal gas "C"	26·4	·546	87·1	90·6	4·06	69	5·9	11·7	44	34	63	4·7	13 0	33	22
p.	441																
Set 8 .	446	Semi-carburetted water gas	24·6	·538	86·4	91·0	3 73	61	6 7	9·0	45	48	48	4·3	11·3	36	19
p.	409																
Set 5 .	373	Coal gas and air	43·8	·653	86·3	89·8	2·88	65	7·8	8·2	41	58	58	6·2	9·4	36	38
p.	335																
Set 2 .	368	Coal gas, very high inerts	38·8	·645	82·2	87·4	3·02	39	6·8	5 8	65	43	39	6·8	5·8	57	43
p.	330																
Set 9 .	365	Coal gas and B.W.G. 1:2	20·2	·572	85·3	93·2	3·87	46	6·2	7·5	44	37	41	4·5	9·1	36	20
p.	330																
Set 7 .	314	B.W.G.	19·0	·635	86·1	97·2	2·31	41	7·3	5·6	51	45	37	5·4	6·8	42	27
p.	285																

SUMMARY.

In Table No. XVI. the principal data have been collected, with information as to the maximum illuminating power obtainable, and the most efficient condition with respect to the conversion of the heat units of the gas into light, for each gas tried.

In view of the vast number of burners now in use, and the machinery and capital involved—to say nothing of the trouble and expense of modifying such burners, assuming that slight modification would give compensating advantages—the maximum illuminating power that the consumer could obtain is shown in Table XVII., if he were supplied with certain pressures on his services, with the burners now in use. Considerations of efficiency or cost are for the moment left out of account.

TABLE No. XVII.

Calorific Value.	Type of Gas.	Sp. Gr.	Maximum Available Pressure "Tenths" Water Gauge.				
			15	20	25	30	35
			Maximum Attainable Candle Power.				
615 552	Coal gas "A"	·430	53	53	53	53	53
525 472	Coal gas "B"	·519	59	70	76	78	80
488 441	Coal gas "C"	·546	43	58	66	69	69
446 409	Carburetted water gas	·538	40	49	54	58	60
373 335	Coal gas and air	·653	25	36	44	51	56
368 330	Coal gas high inerts	·645	14	19	24	28	53
365 330	Coal gas and Blue water gas	·572	32	41	44	46	46
314 285	Blue water gas	·635	22	30	36	38	39

SUMMARY OF INCANDESCENT LIGHTING.—LOW-PRESSURE UPRIGHT BURNER.

(1) For satisfactory lighting with incandescent mantles it is necessary to place the mantle exactly in the zone of active combustion of the gas mixture.

(2) Or, since the burner and mantle are in practice fixed, the zone of active combustion must be made to fit the mantle.

(3) The above requirement is so stringent that, with all gases which could be proposed as reasonably suitable for public supply, other considerations—such as that of flame temperature—become relatively unimportant.

(4) The means of varying the position and character of the zone of active combustion are: (*a*) Varying the gas consumption; (*b*) varying the degree of aeration.

(5) With gases of about 450 B.Th.U. gross and below, the control possible to obtain by varying the consumption and aeration was not sufficient to give satisfactory illumination.

(6) With the burner used, a gas of about 550 B.Th.U. gross maximum to 500 B.Th.U. gross minimum gave the best performance, both as regards efficiency and total illumination; but gases of about 600 B.Th.U. gross per cubic foot gave inferior results, owing to defective aeration.

(7) Gases of low calorific value and high inerts were found to be distinctly inferior, on all grounds, to gases of similar low calorific value but low inerts—*i.e.*, consisting mainly of low-grade combustible matter.

(9) The effects of inerts up to 20 to 25 p.ct. were less marked in the case of gases of calorific value 500 to 550 gross; being, in fact, practically negligible.

(10) The maximum attainable illumination was found at about 525 B.Th.U. gross.

(11) When a reduction in illuminating power and efficiency accompanies a reduction in calorific value or an increase in inert constituents, the result is due immediately to the unsatisfactory size and shape of the flame and its position with respect to the mantle.

(12) A gas in which the inerts are largely in the form of air does not behave as poor gas, but as an equivalent volume of the original air-free gas.

INVERTED INCANDESCENT MANTLES.

We have in the foregoing clearly demonstrated the great importance of flame size and flame shape upon the efficiency of the upright incandescent burner. We have, therefore, no justification for applying the results obtained with upright mantles to inverted mantles, in which the size and shape of the mantle are totally different, and in which the flame shape and distribution of the zone of active combustion are of a totally different order. Nothing but experimental tests can give reliable evidence upon this matter, and tests with inverted mantles under conditions analogous to those which have been carried out with upright mantles are being proceeded with at once.

PART III.

GAS-FIRES.

Heating by gas-fires represents one of the more recent fields for the application of gas; and, but for the war, considerable development would have taken place in this direction.

Not only have we to consider the gas-fire as a means of heating a room, but we have to pay attention to the manner in which the heat is distributed—to some extent by the slow processes of convection and conduction, but mainly by the free and rapid transference of radiation. This radiant heating is not only thermally effective, but has undoubted hygienic advantages, and accompanies the appeal of a cheerful fire. The performance of a gas-fire has come to be gauged by its radiant efficiency—*i.e.*, by the proportion of the total heat of the gas burned which the fire emits by radiation. The comparative merits of different grades of gas for use in fires cannot be tested so usefully in any other way; and radiant efficiency has, therefore, been made the basis of comparison in all the following tests.

After the discussion in Part II., in connection with incandescent lighting, it will assist matters considerably if we regard the "fuel" or "radiant" of the gas-fire as a "mantle"—much heavier and more clumsily made, and emitting radiations of a different character, but subject to similar considerations. Some years ago a method of testing the radiant efficiency of gas-fires was initiated by the Gas-Heating Research Committee, at a time when the differences in efficiency of gas-fires were very considerable. The results obtained were extremely valuable; but no claims to strict accuracy were advanced.

One important preliminary to the investigation in hand has been the examination of this method, leading to the conclusion that, in spite of certain limitations and defects, the method is most useful in practice, and in principle perfectly sound. It was

described before the Institution in 1909. The main objection to it is on the score of the time required for a test when eighty-one observations have to be made. Moreover, some of the readings contribute a very small percentage to the final result, although consuming an aliquot portion of the time in taking.

In a paper read before the Royal Society, Messrs. Bone, Callendar, and Yates proposed a method involving only five readings—viz., at 0/0 and at 60° N.E.S.W. on the surface of the imaginary hemisphere enclosing the fire; and they claimed that the result was practically as good as that obtained by making the full number of readings. Such an assertion was based upon assumptions only partially fulfilled in existing gas-fires.

A considerable number of results have been examined with great care; and the conclusion has been reached that for most fires the statement is only approximately correct, and that for certain fires (*e.g.*, the "R.H.D.") it is seriously in error. However, for any particular fire, the difference between the full determination and the shorter one is constant, even with fires burning under varying conditions as to gas quality and gas consumption.

In this investigation, where the same fire is repeatedly tested to obtain the total radiation only, as distinct from its distribution, the use of this approximation for shortening the work has been considered justifiable. The results are entirely satisfactory when they are carefully calibrated against several determinations by the original method for each fire employed. Isolated tests (however carefully they may be conducted) are open to objections not yet overcome; and the selection of standard conditions for testing is equally full of pitfalls.

The plan followed has been to develop, by systematic trials, the maximum possible efficiency with a particular gas and fire, and to note the conditions under which the results were obtained.

Method of Testing.

The measuring instruments used thoughout have been a thermopile made for the Committee by the Cambridge Scientific Instrument Company, the R. H. Smith radiometer, and the Richmond radiometer. Comparative tests of the latter against the R. H. Smith radiometer have shown that, with careful use, the two instruments give practically the same result, while the Richmond instrument is the most convenient to handle.

The first is first carefully adjusted to burn the gas at a predetermined rate—25, 30, 35, or 40 c.ft. per hour; and after burning for at least an hour, a test is made of the radiant efficiency. The shortened method of testing indicated above is used, calibrated against several determinations by the original method. The air adjustment alone is then varied; and, after waiting some little time, a further test is made. Several trials usually result in a maximum efficiency being found for the particular quality and gas consumption in use. The process is then repeated at different gas consumptions; and the respective maximum efficiencies for a number of consumptions are plotted. The peak of this curve represents the maximum efficiency for the gas under test. In all cases the efficiency referred to is the "radiant efficiency—*i.e.*, the ratio of the number of heat units radiated into the room, to the number of heat units supplied by the gas, in the same time, expressed as a percentage.

Gas-Fires Used.

The object of the investigation being to test the efficiency in use of gases and gas mixtures and not that of appliances, it was hoped that the same fire might be used for all tests (as with the gas-rings and gas-burners), and that we might, therefore, regard all our results as comparable. This hope has not been completely realized; and some time has been spent in repeating tests when circumstances have compelled us to change the fire. The reason for the change has usually been that the fire in use for the tests has given unsatisfactory results when the quality of the gas has been too far altered—a want of flexibility in the fire.

Fortunately, the reasons for the trouble are usually quite obvious. The means of regulation of the primary air is in many cases inadequate. With most fires there is difficulty in supplying sufficient gas to give the necessary heat units per hour as the quality of the gas is reduced without resorting to excessive pressures. When, and to what extent, these features are to be regarded as defects of the gas in use or defects of the fires, is a matter for consideration.

The fires used were 10-in. fires of simple design and construction; the object being to exclude irregularities in measurement due to big canopies or projecting portions of the framework.

The tests are given in numerical order and reported in sets according to the gas used.

Set No. 1.

Fire No. 1 used for all tests from No. 1 to No. 16.

Type of Gas.—Straight coal gas of good quality.

Composition.		Inert Constituents.		Calorific Value.
CO_2	6·8	CO_2	6·8	559 B.Th.U. gross per c.ft.
O_2	0·3	O_2	0·3	503 B.Th.U. net ,, ,,
HC	2·9	N_2	10·3	at 60° Fahr. and 30 in. wet
CO	10·3			
H_2	37·9	Total	17·5	
CH_4	31·5			Ratio gross/net, 1·111
N_2	10·3			
	100·0			Sp. gr. ·535

Volume of air required per cubic foot of gas	4·8 c.ft.
Volume of self-combustible mixture per cubic foot of gas	5·8 c.ft.
B.Th.U. per cubic foot of self-combustible mixture	96 B.Th.U. gross.
,, ,, ,, ,,	86 B.Th.U. net.
Volume of products of combustion per cubic foot of gas	5·6 c.ft.
B.Th.U. per cubic foot of products of combustion	100 B.Th.U gross
,, ,, ,,	90 B.Th.U. net.

Tests Nos. 1, 2.—Although the gas consumption is only moderate, the radiants are heated fairly uniformly to the top. Flames are visible above the radiants, and the flames are poorly aerated although the air-ports are fully open. The fire does not appear to be very hot.

Table XVIII.

Test No.	C.Ft. per Hour.	B.Th.U. Gross per Hour Supplied.	B.Th.U. Net per Hour Supplied.	B.Th.U Radiated into Room.	Efficiency. On Gross C.V.	Efficiency. On Net. C.V.	Pressure in Tenths.
1	23·73	13,260	11,942	4305	32·5	36·1	7
2	23·59	13,215	11,847	4322	32·7	36·5	7

Set No. 2.

Type of Gas.—Straight coal gas D.

Composition.		Inert Constituents.		Calorific Value.
CO_2	3·5	CO_2	3·5	499 B.Th.U. gross per c.ft.
O_2	1·8	O_2	1·8	452 B.Th.U. net ,,
HC	3·1	N_2	17·7	at 60° Fahr. and 30 in. wet.
CO	12·4			
H_2	38·7	Total	23·0	
CH_4	22·8			Ratio gross/net, 1·103
N_2	17·7			
	100·0			Sp. gr. ·533

Volume of air required per c.ft. gas	4·0 c.ft.
Volume of self-combustible mixture per c.ft. gas	5·0 c.ft.
B.Th.U. per c.ft. self-combustible mixture	99 B.Th.U. gross.
,, ,, ,, ,,	90 B.Th.U. net.
Volume of products of combustion per c.ft. gas	4·1 c.ft.
B.Th.U. per c.ft. products of combustion	103 B.Th.U. gross
,, ,, ,,	94 B.Th.U. net.

Tests Nos. 4, 5, 6.—Fires silent; uniformly heated to top of the radiants; tendency for flickering flames to come through the top of the radiants; fire is hotter that in tests Nos. 1 and 2; flames poorly aerated.

Test No. 7.—Radiants fairly uniformly heated for two-thirds their height; no flames above radiants, but flames still seem poorly aerated.

Tests Nos. 8, 9.—Fires silent; an obvious excess of gas being used; the flames are long and wavering; definite flames above the radiants; poor aeration; fire fairly uniformly heated, but does not appear particularly hot.

Test No. 10.—Would be in condition of a fire when ordinarily turned low; radiants fairly uniformly heated one-third their height; flames obviously too small to fill the radiants, and poorly aerated; very faint luminous tips to flames; general effect of the fire depressing.

Table XIX.—See also Fig. 20.

Test No.	C.Ft. per Hour.	B.Th.U. Gross per Hour Supplied.	B.Th.U. Net per Hour Supplied.	Efficiency. On Gross C.V.	Efficiency. On Net C.V.	Pressure 1-10th In.	
4	30·21	15,076	13,670	35·2	38·8	10	Efficiencies low from unsuitable radiants.
5	30·21	15,076	13,670	35·2	38·8	10	
6	29·44	14,687	13,306	36·0	39·7	9½	
7	20·84	10,400	9,459	33·5	36·8	5	
8	36·19	18,057	16,460	32·4	35·6	13	
9	36·40	18,144	16,420	32·8	36·2	13½	
10	9·72	4,847	4,386	29·0	32·0	2	
14	25·64	12,792	11,668	40·1	43·0	18½	

From the results given in Table No. XIX. it will be seen that the fire gives a maximum efficiency upon the net calorific value of 39·7 p.ct. at a gas consumption slightly under 30 c.ft. per hour. It is perfectly silent in use; but aeration seems to be extremely poor.

Upon looking at fig. 20, it will be seen that the curve possesses a distinct maximum. This seems to be a general characteristic of all fires, and has been noted by other observers. Below the maximum the radiants are not fully heated; the flames being as a rule too small to fill the radiants. Beyond the maximum, it is usual to find the flames either going beyond the radiants or coming outside them, and creeping up the front. But in any case the heat is not being properly applied to the radiants; and although the actual number of B.Th.U. radiated into the room per hour may be greater, the radiant efficiency is less. The conditions are exactly analogous to the difference between the point of maximum

illumination and the point of most economical illumination discussed in the Lighting Section.

The figures obtained for the radiant efficiency with this fire are distinctly lower than those usually assumed for a modern fire of this type.

Test No. 14.—For the purposes of this test, the radiants of No. 1 fire were removed and replaced by others of a different pattern. The gas used was sufficiently close in composition to that of Set No. 2 to require no separate and complete analysis. The results are given on the last line of Table XIX. It will be noted that there is a distinct improvement in the results; but they are still considerably below the average.

Set No. 3.

As a gas of similar calorific value, but totally different composition, semi-carburetted water gas was employed.

Tests Nos. 15, 16.—The fire is silent, and about five-sixths of the radiants are heated; the flames appear to be well aerated, with very distinct blue inner cones; the incandescence is good, and the fire seems to be hotter than with the coal gas of similar calorific value hitherto employed.

Type of Gas.—Semi-carburetted water gas.

Composition.		Inert Constituents.		Calorific Value.
CO_2	7·1	CO_2	7·1	526 B.Th.U. gross per c.ft.
O_2	1·0	O_2	1·0	486 B.Th.U. net ,, ,,
HC	7·3	N_2	11·2	at 60° Fahr. and 30 in. wet
CO	28·1			
H_2	35·4	Total	19·3	Ratio gross/net = 1·082
CH_4	9·8			
N_2	11·2			Sp. gr. ·650
	99·9			

Volume of air required per cubic foot gas	4·1 c.ft.
Volume self-combustible mixture per cubic foot gas	5·1 c ft.
B.Th.U. per cubic foot self-combustible mixture	102 B.Th.U. gross
,, ,, ,, ,,	95 B.Th.U. net
Volume products combustion per cubic foot gas	4·9 c.ft.
B.Th.U. per cubic foot products of combustion	107 B.Th.U. gross
,, ,, ,, ,,	99 B.Th.U. net

Table XX.

Test No.	C.Ft. Hour.	B.Th.U. Gross per Hour Supplied.	B.Th.U. Net per Hour Supplied.	B.Th.U. Radiated per Hour.	Efficiency.		Pressure.
					On Gross C.V.	On Net C.V.	
15	31·59	16,620	15,352	6748	40·6	44·0	24·5
16	27·33	14,380	13,282	5879	40·9	44·3	19·5

It will be seen from Table XX. that the efficiency of the semi-carburetted water gas is substantially the same as the result of No. 14, in spite of the very great change in the composition of the gas. The same radiants were in use.

Change of Fire.

The aeration with No. 1 fire was faulty; and its capacity for delivering the B.Th.U. required with moderate pressures was too limited. The fire was, therefore, replaced by one similar in design as regards the gas-jets and radiants, but with a different type of injector and air-control. The new fire is not silent and lights-back with gases below 450 B.Th.U. gross per cubic foot if the air-slide is sufficiently open.

This fire will be referred to as No. 2 fire, and was used in the remaining tests now reported.

Set No. 4.

The tests in this set are given to show the result of varying the degree of aeration with the same gas consumption A gas similar in composition to that of Set No. 2 was employed, and of about 530 B.Th.U. gross per cubic foot. Gas rate 25·95 c.ft. per hour.

Results of Tests Nos. 18 to 20.

Test No.	Efficiency on Gross Calorific Value.	Efficiency on Net Calorific Value.	—
18	41·8	46·8	Poor aeration
19	43·0	47·2	Moderate aeration
20	42·4	47·2	Excessive aeration

Test No. 18.—Fire silent; radiants heated nearly to the top; flames poorly aerated, and spreading somewhat around radiants; fire not very bright.

Test No. 19.—Distinct inner cones to flames; slight noise; flames have definite shape, and seem to fit radiants nicely; fire a satisfactory red-heat.

Test No. 20.—Aeration increased. Very distinct cones to the flames, which are much stiffer and smaller—too small to make sufficient contact with the radiants for their whole height.

It will be seen from the above results, which are typical, that it seems possible to over-aerate flames as well as to supply them with insufficient air, but that some latitude is permissible before the radiant efficiency is appreciably affected.

Set No. 5.

For this set of tests a good quality of coal gas was diluted with Mond gas, in order to reduce its calorific value and increase the inerts present.

Composition.		Inert Constituents.		Calorific Value.
	P.Ct.		P.Ct.	
CO_2	7·7	CO_2	7·7	385 B.Th.U. gross per c.ft.
O_2	1·9	O_2	1·9	347 B.Th.U. net ,, ,,
HC	1·9	N_2	27·2	At 60° Fahr. and 30 in. wet
CO	7·7			
H_2	33·6	Total	36·8	Ratio gross/net = 1·100
CH_4	19·9			
N_2	27·2			
	100·0			

Volume of air required per c.ft. gas	3 2 c.ft.
Volume self-combustible mixture per c.ft. gas	4·2 c.ft.
B.Th.U. per c.ft. self-combustible mixture	92 B.Th.U. gross
,, ,, ,, ,,	83 B.Th.U. net

Table XXI.—(Tests Nos. 23 to 27.)

Test No.	C.Ft. per Hour.	B.Th.U. Gross per Hour Supplied.	B.Th.U. Net per Hour Supplied.	B.Th.U. per Hour Radiated.	Efficiency.		Press. at Burner.
					On Gross C.V.	On Net C.V.	
23	26·64	10,192	9,182	4464	43·8	48·6	15·5
24	26·35	10,150	9,146	4389	43·2	47·8	15·3
25	26·01	10,020	9,028	4146	41·4	45·9	15·2
26	37·02	14,160	12,750	6238	44·1	48 9	30·0
27	37·02	14,160	12,750	6257	44·2	49·1	30·0

In spite of the low calorific value and high inerts, the percentage radiant efficiency is seen to be practically the same as obtained from the richer gases previously tested. Sundry tests have been made in which the calorific value of a good coal gas has been reduced by the addition of considerable quantities of air. There is not yet sufficient evidence for the expression of a critical opinion; but it can be said without any hesitation that the results are not markedly superior to those obtained from a thermally equivalent volume of coal gas burned in the ordinary way. In some tests the results are inferior; but this can be traced to the fact that the flames suffer from over-aeration—combustion taking place before the flames come into proper contact with the radiants.

Summary.—Gas-Fires.

The investigation of the efficiency of gas-fires is not yet complete, and the work is still in progress; but the results obtained so far may be summarized thus:

(1) With each gas-fire there is a certain consumption which, for the gas used, gives the maximum radiant efficiency.
(2) If a fire is turned down so that less than half the radiants are heated, the efficiency suffers severely.
(3) Existing gas-fires vary very considerably in their ability to adapt themselves to gases of different grades.
(4) The evidence obtained so far points to the conclusion that a difference in the grade or composition of the gas supplied, within wide limits, does not cause any considerable difference in the radiant efficiency of a gas-fire, provided that the mechanical construction of the fire will allow sufficient gas to be passed, so that the same number of B.Th.U. per hour can be supplied to the radiants.

SUPPLEMENTARY MATTER PRESENTED TO THE GAS INVESTIGATION COMMITTEE, AUG. 9, 1918.

The Whole Report was Adopted by the Council of the Institution, Oct, 2, 1918.

The work which has been carried out since the last meeting on May 9 includes the continuation of tests with upright incandescent gas-burners and preliminary experiments with inverted burners. It should be noted that the whole range of testing as regards gas quality has not yet been covered. This is merely a question of time; but circumstances have not enabled us to deal as yet with mixtures of really good coal gas and blue water gas, which might, without dispute, be considered to have low inerts. In addition, time has been taken up in careful check-tests concerned with work previously done, as well as that now in progress, in order to satisfy the Committee that the methods employed in testing are sufficiently accurate for the purpose.

Upright Incandescent Mantles.

In the report certain data are given for the behaviour of a typical burner with different varieties of gas. A second burner of slightly different construction by the same makers has been tried. It is found that this burner will give a greater illuminating power, and that it will deal with richer gas in a slightly more efficient manner than the earlier type. It remains to be seen whether this burner is uniformly better with all qualities of gas, or whether the range of quality over which it gives good results is about the same—the upper and lower limits both being raised. Further experiments in this direction are in progress. While not in any way affecting the essential points presented in the report, these

results demonstrate that it is inadvisable to stipulate or recommend stringent limits until a more comprehensive survey has been made not only of gas qualities, but of typical burners now in use.

Inverted Burners.

Preliminary experiments have been made with the inverted gas-burner, using a bar photometer with radial attachment, in which the intensity of the light is measured in a direction at 60° to the vertical axis of the mantle. Some trouble has been experienced, owing to the fact that the majority of inverted burners are controlled by an adjustable needle-valve injector, while the upright burners usually have fixed injectors. The needle-valve injectors are easy to adjust in practice; but there is difficulty in accurately replacing the needle to its former position if it has been moved to accommodate a different gas. The method at present employed is to work to some predetermined consumption, and to develop the maximum performance of the burner by the adjustment of both injector and air-slide. In the case of the upright burner, adjustment of the air-slide alone was sufficient.

Data as to the behaviour of the inverted mantle with different qualities of gas are not yet sufficiently numerous to justify a definite statement on the subject.

Calorific Values.

A careful comparison of our own and other figures shows that there is a discrepancy between calculated and observed calorific values. This does not necessarily imply manipulative errors either in gas analysis or in calorimetry, but is most probably due to the fact that an analysis (even when correctly carried out by orthodox methods) does not give sufficiently exact data for the accurate calculation of the calorific value.

In all the results given in the report the observed or experimentally determined calorific value has been made the basis of the efficiency calculations.

Inerts.

Since the effect of inert constituents upon the behaviour of a gas is one of the principal points upon which the investigation is focussed, their accurate determination is a matter of considerable importance.

Extensive trials and check tests have led to the conclusion that the direct determination of nitrogen by the oxidation and subsequent absorption of all other constituents, using copper oxide under suitable conditions for the oxidation, is a process which gives both accurate and concordant results. The analyses given in the report have, without exception, been made by this method.

Oxygen or Air Required for Combustion.

In the report the amount of air required for the combustion of 1 c.ft. of the gas has been calculated for each gas, also with the idea of obtaining a value for the B.Th.U. per cubic foot of gas *plus* air mixture—a figure which might have some value in explaining the behaviour of certain gases. This calculated value may be in error for the same reasons, and to about the same extent, as in the case of the calculated calorific value. It seems desirable, therefore, to make this an experimentally determined quantity if a convenient and sufficiently accurate method can be devised. Experiments have been made in this direction, and have met with a considerable measure of success.

[*** Owing to the length of the foregoing report, it is necessary to defer till next week our report of the extended and interesting discussion to which it gave rise.—Ed. "G. J."]

CAPITAL: ITS WASTE AND ITS CONSERVATION.

By Archibald P. Main.

[A Paper read before the Society of British Gas Industries, Oct. 17, 1918.]

I have observed that it is the usual custom of those who are called upon to preside at gatherings such as this—gatherings of practical business men—to attempt to survey the whole economic position; outline the economic effects of the war; gauge present economic tendencies; and, finally, forecast the economic conditions of to-morrow. If this is the accepted view of the duty of the Chairman upon such an occasion as this, I hope you will forgive me for departing in this respect from the path of duty, and for this reason. To anyone who looks out to-day upon the vast panorama of world war, there are so many conflicting influences at work, so many confused threads, so many quite imponderable forces in operation, so much data unobtainable, that the opinion of one man, however wise, is of little value; while the discussion following an address of such a comprehensive nature would have such unlimited scope that it would be almost certain to straggle on into a series of debates upon widely separated and totally unconnected topics.

I have ventured, therefore, to select for my address to you to-day, and for our discussion, one particular economic subject—namely, the waste of capital in war, the unprecedented demand for capital after the conclusion of hostilities, and the means by which British industry can make the best possible use of the credit and financial accommodation which will likely be available when peace returns to us. On the first part of this subject—namely, the extent to which capital is wasted or destroyed in the war—opinions of experts vary widely; and, beyond indicating certain definite facts, I shall not attempt the rôle of umpire between them. The second portion—that is of the best possible use by industry of capital available for its employment after the war—is a very practical theme. It is one that closely affects every one of us; it is one on which too much thought cannot be expended. And I hope that with regard to it we may hear some very useful and weighty opinions and suggestions. And because you are all, I am sure, as anxious as I am to hear what contributions others have to offer to the consideration of this important problem, I will make my own remarks as brief as possible.

Before turning definitely to the specific matter in hand, just a word or two upon a more general aspect of affairs. In August, 1914, we all suddenly saw more clearly than ever before that we are all British citizens first and business men second. For four stormy years, our one main thought has been to concentrate and place at the disposal of our country, and of the whole allied cause all our strength and all our resources. We have all had to submit to many things we do not like, and to some things (in the way of interference), to which in less serious days we should have opposed a very lively resentment. But to-day we are beginning to see before our eyes the harvest of our sacrifice. The glorious victories of the indomitable troops of Britain and her allies, and their splendid leaders, are daily bringing nearer to us the final triumph of justice and freedom. The approach of this triumph, while it does not justify us in relaxing one single ounce of our effort, emphasizes perhaps a second duty, equally essential to the national interest—that of putting our heads together and laying plans for the future. The approach of victory and a real peace has a special message for business men. It is this: "Prepare! Organize! Be ready with your plans; so that you make it certain that the fruits of victory are not frittered away through unpreparedness." When war came upon us, it took us a very long time to establish industrial efficiency on a war basis. When peace returns, let us be found ready with our plans, and not groping about blindly, as we were in the early days of the war. To concentrate upon such plans now is still, perhaps, considered by some to be "fiddling while Rome is burning;" but I do not believe that any practical business man will regard it otherwise than as a patriotic duty, and a duty that become more pressing and immediate as the dawn of peace draws nearer.

Among financial experts and professional economists, there is (as I suggested just now) a division of opinion as to how much of the enormous war expenditure is waste. One school would have it that almost the whole national expenditure on warfare is pure waste, in the economic sense, because the money is not spent on industrially or commercially reproductive purposes. The other school would tell us that our huge expenditure has not reduced our capital assets; it has merely brought about a reshuffling of money inside the country; and, except in so far as we have had to borrow abroad money that has been fired out of our guns, or sold securities abroad in order to pay for munitions, we have not undergone any impoverishment at all. It is not my object to try to decide which, if either, of these two schools is right, or to say what part of the thirty-six thousand millions sterling (which is the estimate of the Swiss Bank Corporation of the total war expenditure of all the belligerents) represents waste, and what part is reproductive in nature. But it seems to me, on the one hand, both dangerous and fallacious to believe that any country can make war on the grand scale without suffering impoverishment. The war has at any rate destroyed a vast quantity of property both by land and by sea. Serbia, Northern France, Belgium, Roumania, and other parts of the world have been ravaged; and the wholesale destruction there represents sheer destruction of capital, as does also the sinking of something approaching 15,000,000 tons of merchant shipping. Then, again, capital depends upon production. In the first place millions upon millions of the world's best and strongest producers have been taken from their work to the battlefield. Not only is the world poorer economically by the loss of what they would have produced during the first four years had peace obtained; but, alas! millions upon millions of the best will never return, for they lie in honoured graves or are crippled with honourable wounds. Calculating from the cold economic point of view, this human loss represents grave waste of capital, both actual and potential. Waste I mean, of course, purely in the economic sense. For if the result of this terrible war is to enthrone justice and right, and to provide security for the future, no part even of the appalling price we have had to pay can really be described as thrown away.

Nor, on the other hand, surely should we be right in describing all war expenses as waste of national wealth; for, to take one example only, hundreds of millions have been spent on factories for war work, which can be transformed into industrial producers for peace needs. Not to go into the question more deeply, I believe that the truth as regards the waste of capital by war lies somewhere in between the conclusions of the two schools of thought to which I have just alluded. In any case, I do not think anyone will quarrel with me for saying that the great demands for capital after the peace will be made upon a world to some considerable (but undefinable) degree impoverished; a world

robbed of a very serious proportion of its best producers of wealth (who at the same time were potential fathers of the next generation of producers); a world overburdened with debt and taxation; a world whose capital assets are very heavily mortgaged.

Moreover, the demand for capital will be heavier than ever before in the world's history. There will first of all be the actual work of repairing definite destruction by land and by sea—buildings, ships, railways, roads, &c., all over Europe—and restoring the industries and reinstating the populations of the areas of devastation. This alone will call for thousands of millions of pounds (two thousand millions sterling is, I believe, the estimate for the occupied portions of France alone); and even if we be determined to make guilty Germany pay in the long run, we have to face the fact that it will not be physically possible for her to pay up at once, for she will face bankruptcy the day the war ends. Whoever may pay in the long run for restoration, the immediate burden of financing it will fall mainly upon the great financial centres of the allied world—London, New York, and Paris.

Next there will come enormous demands for financial accommodation for industry in all countries which have been at war. Take our case here in the United Kingdom alone. For four years industry has been starved of capital. In order that every possible penny should be left free for investment in war loans, a Treasury Committee on new issues has been sitting, whose permision it has been necessary to obtain before putting forward any offer of new capital for subscription by the public. This Committee has had a very difficult task; and, as was inevitable, it has been bitterly criticized. To speak broadly, it has refused permission for any new issues of capital to any industry or business, except in so far as such issue was urgently required for coping with essential war work. For all other industry and trade, therefore, when the war ends, will arise an abnormal overdue demand for the creation of credit. But that is not all. Besides these postponed arrears of natural demand, there is the abnormal demand that will arise for transforming industry from a war to a peace footing; for building up stocks again; for setting trade going once more; and for putting us in a position to pick up the broken threads of our overseas export trade as fast as ever the replacement of our shipping losses by building, purchase, or confiscation from our enemies, can proceed. Over and above all this, there will be a few items—like the provision of houses urgently needed by the rural and industrial population—which will require perhaps a hundred millions in the period immediately following the peace and much more as soon as adequate supplies of material become available; while, as one little instance of many other needs may be mentioned the estimate that at least forty or fifty millions will be needed to place our roads in good repair. Parenthetically, one may ask how much more will be needed under this last head by those in the other countries, where the actual fighting has taken place.

One could, of course, continue this list almost indefinitely; but there is no particular point in doing so. All that I want to lay stress upon is that the demand upon our capital resources—whether for restoration, for making up natural overdue arrears and for financing the transition stage, or for setting trade and commerce on its feet again—will be gigantic. It is not very useful, perhaps, to attempt to put forward statistics in relation to these matters, for the element of guesswork necessarily comes in to a great extent. But I will quote a reference which Sir Edward Holden, the Chairman of the new London Joint City and Midland Bank made to the capital needs of British trade and industry at a meeting of his bank the other day:

> "Bankers," said Sir Edward Holden, "are confronted with the the problem of restoring the industries of the country after the war to the condition which they previously occupied. The concerns which have been converted from peace production into munition factories will have to be reconverted to their original condition. In the case of a number of those branches of industry which have continued in their pre-war occupation—such as those producing for home consumption and for export—the plant and machinery have been allowed to run-down; and it will be necessary to renovate them and bring them up to date, and even to a better condition than before the war. Large sums of money will have to be found for the purchase of raw material, and large sums will also be required to improve the trade position generally. It is estimated that no less than three hundred millions sterling will be required for these purposes; and credit will in some way have to be created for the amount."

Sir Edward then went on to argue, rightly as I hold, that the concentration of financial power effected by the recent banking amalgamations is a great step towards meeting the coming financial demands of industry.

I have said enough, I think, to give some idea of the tremendous nature of the demands which British industry will after the peace make upon our supplies of credit; and it brings me to the second portion of my subject. We have learnt many lessons during the last four years; one of the chief is the lesson of economy. We have learnt to study economy of food, of labour, of paper, and of hosts of other raw materials of life and activity, and many of us have recently been particularly actively (perhaps rather painfully) studying the conservation of coal. After the war we must bring these lessons to fruitfulness in another direction. We must study the "conservation of capital," and the economy of financial credit. Credit resources will not be sufficient to meet the unrestrained and possibly superfluous and extravagant demands of all comers. A question for business men to study is how they can reduce their demands for capital accommodation and how they can make the best use of the available supply.

Several methods of conservation at once suggest themselves. It will readily occur to you, for instance, that before the war huge sums were subscribed in new capital for unsound ventures of a "wild cat" nature, in which the money put up was too often merely thrown in the gutter. We shall not be in the position to afford this kind of doubtful luxury in the days of peace that lie before us. How to check this type of waste it is not easy to see; and the question merits expert consideration. But it is to another method that I wish to invite your close attention. It is the method of co-operation by businesses engaged in the same type of manufacture or trade. By joining together into a large organization, and working as one large concern rather than as numerous small units—as regards such matters as the purchase of raw materials, for instance, and the marketing of products—firms in every branch of industry, would certainly be able to eliminate a very large amount of buying and selling expenditure; and this saving would decrease greatly the amount of working capital required by each individual concern.

To give an example of the sort of thing I have in mind, I need go no further afield than a branch of industry with which you are all well acquainted. In this country there are at least a dozen separate manufacturers of gas-meters. In America, the whole industry is one united organization. One firm makes the brass work, another the leather, and so on. The results are clear. Instead of the duplication of plant, they get concentration of plant; and individual concerns have to carry lighter stocks. Then, by concentration, there is a tremendous saving of purchasing expenses, and of selling expenses, which here in this country loom so large in the expenditure of individual small concerns. Economy in production and reduction in the costs of production are assured; and so far from exploiting the consumer, the concentration works to his advantage. Moreover—and this is very important to-day—out of the money saved, it should be possible to find adequate funds for technical research. Where each member of the organization cannot afford, perhaps, to instal a separate laboratory, each at any rate could afford to contribute its share of the cost of a common laboratory. If such methods were widely adopted by many industries, I think it cannot be disputed that the result would be a very important reduction in the gross demand for the provision of new capital for industry, or, in other words, a great conservation of capital.

In this connection it is worth while noting a very bold scheme which has recently been outlined under the name of the British Corporation for the Reconstruction and Federation of Industries, Ltd. This scheme, possibly because of its very boldness—its proposed capital is a thousand millions sterling—has been severely ridiculed in some sections of the press. But you may take it from me that it is a serious scheme, meriting the study of business men, and that it has some very substantial persons behind it. The objects with which it is proposed to form this British Corporation are precisely the objects (only practised on the grand scale) which I have just been saying could and ought to be obtained by union into a single organization for certain specific purposes of different concerns in the same branches of trade or industry. The scheme in its present form may be full of faults and impracticabilities; I do not say it is not. But I do claim that the objects it seeks to pursue ought to receive the careful attention of all business men. Similar objects are arrived at by the British Manufacturers' Corporation, which was inaugurated the other day with a very able explanatory speech by Sir Charles Mandleberg.

Sir Albert Stanley, our able President of the Board of Trade, obviously had something similar in his mind when he delivered his lecture on "Commerce and Industry after the War" on Oct. 3, at the Saddlers Hall. He said that the experience of our ancestors afforded little guidance in the problems which we should have to solve after the war. British industry and commerce would have to meet not only the competition of Germany, but also that of neutral countries. It was essential that sweeping improvements in our methods of production should be made and in the organization of oversea trade. One of the first problems to be solved was such an organization of industry as would make possible the complete overhauling of our industrial equipment and the establishment of large-scale production.

I know there are many objections that can be raised. There are those who will see in such organizations the foundations of controls and trusts; the elimination of competition; and the exploitation of the consumer. Personally, I believe these fears to be mainly bogies; and incidentally I may note that one of the definite objects avowed by the British Corporation is the reduction of prices to the consumer. Elimination of competition and exploitation of the consumer need not be feared in this country. Behind a high tariff wall they might perhaps become real threats, but not under any conditions which, so far as we can see, are at all likely to obtain in this country after the peace. If I thought otherwise, I should not recommend such lines of action. But if, as I am convinced, such fears are groundless, then the great conservation of capital to which such organization opens the door, should be an inducement to us to concentrate our brains upon this method of meeting one at at least of the serious problems that confront us.

Apart from the opportunity for the conservation of capital thus offered, there is another aspect of such organizations. Before the war, we often found that our industrial and commercial efforts were too isolated and too unsupported to combat the unified strength of the great organizations of the German commercial world. About this aspect of affairs we have learnt a great deal

during the last year or two. A good example of how Germany was working her way in the commercial sphere before the war was provided the other day by the "Morning Post," which published a very remarkable chart displaying the almost incredibly comprehensive network of connections by which the Deutsche Bank was extending the Teuton grip in various parts of the globe. I do not for one moment suggest that all Germany's business methods are suitable for adoption by us, or indeed by any honourable business men. But it is at any rate plain that we should study what her methods were, and learn certain lessons in combination and organization which must be learnt if we are to hold our own in the world competition into which the restoration of peace will plunge us.

But upon this question—important though it is—I will not enter further; for I wish to concentrate this afternoon rather upon the problem of conserving capital. In making the few remarks to which you have been good enough to listen, I have endeavoured not to dogmatize, or indeed to identify myself too definitely with any doctrinaire point of view. I have thought it more useful to proceed rather by way of suggestion; and I hope that, in the discussion upon the points that I have raised, we may hear many opinions which will be helpful in making up our minds on these vital questions, and in laying our plans upon the wisest lines.

DISCUSSION.

Mr. H. JAMES YATES said the paper contained a great deal of food for thought. From experience he had gained in work in connection with the Federation of British Industries, he felt perfectly certain that unless our bankers mended their ways, and were prepared to regard the financing of industries from a totally different standpoint than they had done in the past, manufacturers were not going to get the help which was so essential if they were to hold their own in the fierce competition of the future. The Federation were not content to sit down under the methods employed up to the present by the British bankers. The matter was receiving the most careful consideration; and he personally had no fears as to the result. As to co-operation of businesses in the same trade, there was no greater advocate than he had been of the combining of industries that had more or less common interests. If they were going to hold their own, they had got to combine. In the paper, allusion was made to the combination of American meter-makers. He could refer them to many other organizations formed in America, and some of them since the war. They were coming over to try and capture the industries of some of those represented in the room. It was up to them to meet this competition.

Mr. S. CUTLER, jun., remarked that the paper dealt with a very important subject, and one to which he was afraid that they, as manufacturers, with the past four years of strenuous production and the prolific spending of the capital to which reference had been made, had not given the thought which it deserved. The author said they had learned to study the lesson of economy. Had they? The matter that concerned him (the speaker) most, and which was causing a good deal of anxiety—and they were all, as manufacturers and producers, in the same position—was how they were going to revert to their former economical ways of conducting business after the war. The extravagant manner in which everything was now being carried on, the granting of every demand made by the working man, the unduly inflated prices, the ease with which they got their contracts, and the general conduct of business without the restraining influence of competition, led him to think that they had learned very little about economy during the war. One of their greatest troubles would be to get out of the "disordered life" they were now leading. As to capital, Mr. Main put before them an instance of loss in subscriptions to "wild cat" schemes. Was this money lost, in the sense of regarding the whole capital assets of the country? A loss individually was surely not a loss if applied to the whole community. The war expenditure was £7,000,000 a day; and yet the total available gold and silver in the country at the beginning of hostilities was stated to be less than £200,000,000. So it could not be out of metallic money that the thousands of millions had been spent. If they got away from the fallacy that to spend money was to waste it, they would regard the enormous expenditure of the last four years as being not so serious as Mr. Main contended. Another point in the paper with which he did not agree was the united organization of certain branches of industry. What was the result of the method of manufacture under the conditions that the author advocated? It meant the creation of a monopoly or trust, under which prices would be raised; and there would be a lack of improvements, because they would have squeezed out individual firms, which had been the backbone of British prosperity. Mention had been made of the success of the meter trade in America, where it was stated that the whole of the meters were made on the system that was described. Was it possible to make a meter cheaper in America than in this country—always bearing in mind that the prices of material and labour were considerably higher in America than here? He had occasion a few years ago to investigate the selling prices and general conditions of the meter trade in various countries; and he came to the conclusion that in one country where there was certainly a monopoly of making meters, they could not do as well as in another country where he was associated for the time being with a comparatively small individual firm who were in a position to place meters in this country at a lower price than they could be manufactured for here, and giving a longer guarantee. Take another branch. There were about twenty firms who constructed gasholders; and if they adopted the principle that Mr. Main advocated with regard to meters, what were they all going to do? Possibly his own firm would be relegated to making the bolts and rivets. What about the seventy years' experience that his firm had had in the designing and construction of gasholders? What interest would they have in improving the design? And they had had seventy years' experience, because it was only a few days ago that he came across some drawings of holders constructed by his grandfather as long ago as this. Was this experience all to be lost under the new conditions? As to Germany, a good deal of misconception existed. It did not follow that the ramifications of a firm with a high-sounding title were any greater than many concerns in this country. In the paper the Deutsche Bank had been mentioned; and no doubt banking facilities existed in Germany which did not exist here before the war. The Deutsche Bank had a financial interest in the firm who took the order for the Tottenham gasholder just before the war. Apart from obvious reasons why this would never be carried out, another reason was that a kind Government would no more exist over there to pay the firm's losses by the subsidy promised them in connection with the contract.

SIR ARTHUR DUCKHAM remarked that the paper was of the greatest interest to him. They would have to face these problems. One thing that had been borne in upon him during his work was that it was working capital which they would want after the war. He agreed that this was perhaps the chief form of capital which would have to be looked after. This certainly could be obtained by economy. But the great thing was that, if they could get a proper production from their workpeople—not by sweating, but by allowing them to share the benefits of production, and thus inducing them to produce in accordance with their abilities—the country would pay for the war very readily. The greatest matter they had to face after the war was the securing of confidence between workers and employers. When they heard of girls earning, on the same piecework rates as before the war, five times as much as any man did before the war, it would be seen what a great margin there was. Reduction of overhead charges meant reduction of working capital. As to Mr. Cutler's remarks on combination, he (the speaker) did not think Mr. Main meant his suggestion to be taken in that way. When the combination was effected, the firms would get busy among themselves, and settle which parts of an article each could best make, and how they could best be brought together for the final product. And then they would split the value of the final product into the parts each had made. It was only by all having an interest in the final product that any scheme such as the author put forward would be possible. There was great work coming on after the war; and the earliest thing would be to divert the flow of raw material from munition purposes into industrial branches. What they would all have to face just at first was how they could best introduce into their workshops raw material for other than war purposes. The raw material would be there; the only question would be how best to utilize it.

Mr. H. M. THORNTON agreed that the question of production after the war was the most important thing for them to consolidate their thoughts upon. It seemed to him that, when they considered that this nation possessed practically a quarter of the world, there should be within the Empire itself sufficient wealth and sufficient possibilities, even if they did not take into account the other portions of the globe which were available for the output of their products. Remembering before the war what an enormous output they had for a small nation like England, and comparing it with America or Germany, which possessed very much larger populations, he thought it was very wonderful that this country was able to export and import such an enormous amount as they did with such a moderate population. The outlook for the British Empire had never been so wonderful, had never been so full of possibilities, as it was to-day. If they consolidated their interests and made the best of their opportunities by fair trading, he was satisfied that they would have a future so full of prosperity that it might—he was going to say—be even detrimental to their true interests to have it. All this, however, could be brought about only on one condition—that the employer and the workpeople came together on satisfactory terms. How this was to be accomplished was a problem full of difficulties; but he did feel that they had to face it. If they could only get the workpeople of this country represented, as they ought to be, by responsible men looking after their interests, who would see that these interests were not dissociated from the interests of the employer, but part of them, then they need not fear for the future of their Empire and their trade, and the prosperity of the world in which they lived.

Mr. F. D. MARSHALL asked permission to make a few remarks on the consolidation of effort and the "conservation of capital." As one of the very few Englishmen who enjoyed the friendship of the late Dr. Walter Rathenau, the founder and head of perhaps the world's greatest commercial enterprise—the Allgemeine Electricitats Gesellschaft, of Berlin—he would like to tell them of a conversation he once had with him. It was years ago; but it made a great impression on him at the time, and in his own words he would endeavour to give them the purport of it. He put the question to Dr. Rathenau whether the absorption of small industries by huge concerns such as his did not tend to suppress individualism—meaning, of course, the crushing of individual effort and enterprise, with the consequent subservience of them to the domination of a commercial oligarchy. He replied, "Yes, to a great extent it is so; but it is not a detrimental subservience. Let me try and formulate to you the principles of the doctrine which actuates us. First and foremost we hold that the efforts of the individual must be primarily directed to the welfare of the State and the Fatherland. You must know that, industrially speaking, we have hitherto been a small nation, but that, owing to an advanced education, the brains, technically speaking, of our people have been far in advance of the opportunities for the exploitation of the same. Numbers of small industries have established themselves, replete with brains, but with capital lacking. Consequently, their orbit of operations has been limited. Our banks, as you know, have been wonderfully accommodating and elastic in helping small concerns; but, all said, they would have remained small. You, who are so conversant with our industries, need no telling how we have in late years, by a dynamic force, carried our trade to the uttermost corners of the earth. We have challenged your supremacy; and we shall challenge America's. This could never have been done, had all these minor industries which we have gathered into our net been left to themselves. They would have remained merely parochial concerns, commercially prosperous perhaps in a small way, but useless to push the great German industry far afield, to the Argentine, South America, the Far East, your Colonies, and other places, to the benefit of the State and country. We absorbed them, and shall go on absorbing them. These concerns are often directed by some of our cleverest people. We absorb these people. The banks—small banks, which finance them—well, we absorb them, too. But, tell me, has the state of Germany suffered by so doing?'

Yes, I we suppress individualism, as you may term it; but we substitute something better, which I will call 'collective individualism.' We bind all these loose individual sticks into strong bundles. You remark that we are a big 'trust.' Worse than anything America ever conceived. Perhaps so, but we are a trust that redounds to the welfare of the scientists, the welfare of the workman, the welfare of the people, and the welfare of the German State." These words bore out much that the author indicated in his valuable communication, and pointed to the principle that if this country was to redeem its lost world trade in the future, and to conserve capital, it must be by powerful combinations free from small commercial rivalries, and helped if necessary by the State.

Mr. MAIN remarked that one of the considerations that had led him to write on the subject was that after the war there would be fierce competition on the part of Germany to recover her position in the world. Another was that America would become an increasingly powerful competitor in all our industries. And the third was that raw material to-day was in many cases not only double, but more than double, what it used to be in price.

MIDLAND JUNIOR GAS ASSOCIATION.

Opening Meeting of the Session.

The opening meeting of the session of the Midland Junior Gas Association was held in Birmingham on Thursday last. Mr. R. G. MARSH (the retiring President) occupied the chair at the outset. Some thirty members were present.

INDUCTION OF THE NEW PRESIDENT.

The PRESIDENT, in inducting his successor in office (Mr. T. H. Poulson, of Stafford) said he had a great admiration for Mr. Poulson as a man of energy and capability.

A hearty vote of thanks was accorded to Mr. Marsh for his services, on the motion of the new PRESIDENT, seconded by Mr. HAROLD JONES, the junior Vice-President.

INAUGURAL ADDRESS.

The PRESIDENT devoted a large portion of his address to the subject of pile-driving at Stafford, to provide stable foundations for the buildings at the Stafford Gas-Works, which are contiguous to the River Stour. He dealt first of all with the substrata on which the works are erected, and then described the three types of piles used (as follows) to prevent subsidence:

(1) (*a*) Pitch pine. Length, 26 ft. to 53 ft.; cross section, 10 in. square.
(*b*) Pitch pine. Length, 35 ft. to 85 ft.; cross section, 12 in. square.
(2) Moulded reinforced concrete, "B.R.C." type. Length, 26 ft. to 37 ft.; cross section, 12 in. square.
(3) Stewarts' "C.P." concrete-tube system. Length, 42 ft. to 55 ft.; diameter, 16 in.

They were used as follows:

(1) (*a*) In the old portion of the works in the foundations of horizontal retorts and chimney, condensers, scrubbers, purifiers, and railway bridge. (*b*) In the newer portions under the carburetted water-gas plant and buildings, relief holder, oil-storage tanks, sulphate plant and buildings, boiler-house and chimney, and the tar storage tanks.

(2) In the foundations of the 1½ million cubic feet per day vertical retort installation and coke plant.

(3) Under the scrubber-washer, benzol plant, and the oil and acid storage tanks.

After describing the preparation of the various piles, and the pile-driving apparatus employed, he detailed the operations for framing and driving the piles, the method of lengthening them, and the preparation of the foundations above the piles. He then dealt in detail with Stewarts' "C.P." concrete piles, in which system, cylindrical steel tubes are driven into the ground to the required set, filled with concrete, and withdrawn, leaving a column of concrete, which constitutes the pile, in the ground. Thus, there is no pile-driving as such, no damage to piles by splitting or breaking, no lengthening required, and little cutting. The apparatus required is similar to that used in the ordinary system, with the principal addition of the cylindrical steel tubes, which vary in length from 8 ft. to 50 ft., and have a diameter of 14 in. internal and 16 in. external. The ends are made spigot and socket.

He mentioned that no subsidence has been observed in buildings erected on piles carrying the following load per pile:

Pitch pine, 12 in. square	16 tons.
Reinforced concrete, "B.R.C." type	37 ,,
Stewarts' "C.P." tube system	33 ,,

Dealing with the advantages of concrete over timber piles, he stated these as being:

(1) The material used in their manufacture can be obtained in any locality.
(2) Reliability, due to even consistency of material throughout.
(3) They do not rot—age, within limits, increases their strength.
(4) They carry a greater load; therefore fewer piles are required.
(5) It is not necessary to drive them below land water-level; consequently much excavation, concrete, and brickwork footings are saved.
(6) Foundations immediately above the concrete piles can be united with piles, and not merely laid on the top, as in the case of timber foundations.

As to the effect on near-by buildings, he said: Although the apparatus used in pile-driving is large and somewhat unwieldy, piles may be driven within 18 in. of existing buildings and mains. The vibration caused by driving is not harmful, provided that shallow underground mains are bared. Finishing his remarks upon piles, he commended the subject of concrete piling as being worthy of the consideration of engineers who are erecting large buildings on ground which necessitates deep excavation to obtain a foundation, as it will be found in many cases to be the less costly method.

The concluding sections of the address dealt with economy and efficiency and the subject of inadequate salaries—addressing the junior members of the Association more particularly on the former subject.

ECONOMY AND EFFICIENCY.

I have thought it opportune to include the following remarks on economy and efficiency for the benefit of our junior members; and if the points become a source of investigation by them, the address will have been worth while. In the first place, as so much fuel is used in the gas industry in generating steam by means of Lancashire boilers, the average efficiency of which is only 62 p.ct., it is evident that the subject of boiler efficiency deserves greater attention than is generally bestowed upon it. If only trouble were taken to teach boiler attendants the elementary laws of combustion, and how to apply them, there would be saved much valuable fuel, unnecessary labour, wear and tear of boilers, and a considerable amount of the pollution of the atmosphere caused by the emission of black smoke from the chimney.

Let us consider for one moment the operation of cleaning the fire, as carried out by the average boiler attendant. He first pushes the live fire to the bridge, over which, in so doing, a portion falls, and is lost; then he loosens the clinker with a clinkering bar, pushing the bar right under the clinker near the bridge, over which he loses more hot fuel. He then has about 12 sq. ft. of grate area exposed to cold air draughts, thereby cooling the flue, and adding greatly to the wear and tear of the plates.

The above is the wrong method, and should an attendant be seen adopting it, explain to him the correct and economical way. This is: Move all the live fuel to one side of the tube, remove the clinker from the bars, and then move the fuel over to the clean side, and finish clinkering. After this process, the live fuel must be spread evenly over the bars, and fresh fuel added. In rebuilding the fire, care must be taken that the fuel is put on first at one side, beginning at the front, and then at the other, in the same way. This method is known as "side-firing," and should always be adopted in hand-fired boilers, as the necessary warm-air supply for igniting the liberated gases is obtained from the opposite side to that stoked. In this way, a more uniform furnace-temperature is maintained than when the fire is charged over the whole area; and thus the emission of dense black smoke from the chimney is obviated.

It is most important that an even fire should be maintained, and this is achieved by adding small quantities of fuel when the fire is at its brightest. The unskilled boiler-attendant, instead of watching the fire for an indication as to the correct time for recharging, waits until he sees the steam-gauge falling, when he adds a large quantity of fuel. The results are that the steam-gauge continues to fall until the furnace temperature reaches the point when the carbon and oxygen combine, and much smoke is emitted from the chimney—the loss during this black smoke period being often as much as 10 p.ct. of the fresh fuel added.

Further fuel will be saved if the boilers are kept free from scale by being regularly let-down and washed-out; if all the flues are kept clean—not forgetting the often-neglected main flue from boiler to chimney; and if attention is paid to the brickwork around the boilers—repointing being done as required, for the expansion and contraction caused by the letting-down of boilers moves the brickwork and causes cracks, which allow cold air to be drawn into the flues. Finally, as regards boilers, I would remind you that economy lies in working an extra boiler rather than forcing those already in use.

Much fuel is lost indirectly in the steam-pipe range by radiation from uncovered pipes, inefficient traps, valves, valve glands, and the continuous use of steam ejectors. Have all leaking joints repaired as soon as possible, not only because of the loss entailed, but also because they may quickly blow out. In this connection, remember that a faulty joint may be the cause of an inconvenient shut-down. See that steam is not wasted by inefficient or worn engine and pump parts. It is advisable to take off the cylinder covers occasionally, as badly-fitting piston-rings and slide-valves are a source of recurrent loss. Inefficiency is caused by grooved or unparallel piston and pump-plunger rods; for, in order to prevent escape of steam, &c., the packing has to be screwed so tightly against the rods that undue friction is put on them. Consequently, additional power is required to work the machine. Such rods should be turned true, a new neck ring fitted in the stuffing box and the gland bushed. In small machines, it is often cheaper to fit a new rod.

Particular attention should be given to the loss of ammoniacal liquor, as, apart from the actual washing apparatus and the subsequent recovery plant, ammonia is wasted by leaking gland cocks, pump glands, and faulty pipe lines. It is preferable that pump delivery pipes should be fixed in sight, above ground, and the outlet ends sealed in the liquor. Plug cocks should never be used. Loss of ammonia occurs while the liquor is standing in storage tanks; but this can be partially prevented by the addition of a

small quantity of waste lubricating oil, which forms a film on the liquor and prevents evaporation.

In concluding these remarks, I would impress upon our junior members the importance of keeping all apparatus, &c., clean; for not only is clean machinery subject to much less wear and tear, but a clean works helps to create an atmosphere of smooth running, resulting in greater efficiency of plant and of men employed.

INADEQUATE SALARIES.

Recently much has been written regarding the inadequate salaries paid to gas engineers and their assistants; and although it is difficult to see how a Technical Association can be of benefit to its members in this respect, I feel that some good might result if the Senior Association could, in some way, rouse the owners of works to the advantages they would gain by paying adequate salaries.

It is most discouraging for both parents of boys who are desirous of entering the profession, and those already engaged in the industry, to read in our Technical Press advertisements for both engineers and assistants, in which a bare living wage is offered. Not long ago, a wealthy corporation, making over 600 million c.ft. of gas per year, invited applications for the post of "Engineering and Chemical Assistant" at a salary of £150 per annum. Another invited applications for the post of "Technical Assistant," salary £120, with war bonus (whatever that may be). The applicants were to possess the usual qualifications of a good knowledge of gas-works routine, and the ability to prepare drawings, specifications, &c., of any new work required. Considering the great cost of educating and training a man capable of creditably fulfilling either of these positions, the salaries offered are ridiculous.

In the end, this policy of paying inadequate salaries must have bad results; for there is no doubt that, unless greater inducements are offered to the prospective gas engineer, the right class of man will prefer more lucrative employment, and the time will soon arrive when there will be a dearth of men qualified to uphold the high traditions of the industry.

Vote of Thanks.

Mr. Harold Jones proposed a hearty vote of thanks to the President for his able and interesting address, which would prove a valuable addition to their "Transactions." The programme arranged for the session appeared to promise that both papers and visits would be of exceptional interest.

Mr. Marsh, in seconding the vote of thanks, said he had listened with great interest to Mr. Poulson's address, which was all the greater because he had had the privilege of seeing the work at Stafford. The site there was one to break the heart of any but an energetic engineer; but the problems associated with it were in the everyday work at Stafford. Mr. Marsh asked several questions in reference to the several types of piles.

Mr. W. J. Pickering (Birmingham) supported the vote of thanks, remarking that the visit to Stafford arranged for March next should prove highly interesting after the very original and useful information as regards piling given in the President's address. The section dealing with "efficiency and economy" was very much to the point; and he could assure the members that this gospel was one which Mr. Poulson himself practised on the Stafford works.

Mr. W. Batt (Birmingham) said the address was one which should appeal to the building trade as well as the gas profession. It was, he believed, the first paper of its kind, dealing exhaustively with piling, which had been delivered before any Gas Association.

Mr. Whitehead (Manchester Junior Gas Association) said he had pleasure, as an old member, in supporting the vote of thanks. The address was highly original as to the information regarding piling, and the other matters mentioned were timely and important. He expressed the wish that Mr. Poulson's year of office would be at least as successful as the past session.

The President then replied to the vote of thanks and to several questions raised by the various speakers in reference to the piling operations.

"Transactions" of the Ceramic Society.—Vol. XVII. (Part II.), session 1917-18, of the "Transactions" of the Ceramic Society, including the Refractory Materials Section, is a bulky book published by the Society at Stoke-on-Trent, the price to non-members being 45s. per volume. Some of the papers of more particular interest to "Journal" readers have already received notice in our pages; and among them special reference may be made to that by Mr. J. P. Leather, of Burnley, on "Refractory Materials in a Gas-Works, from a User's Point of View." A considerable part of the book is devoted to abstracts of articles, &c., concerning the industry which have been taken from various sources.

A Big "Carbocoal" Plant.—The Fuel Administration of the United States announce that, as the result of tests made of "Carbocoal," the Government have become interested in the establishment of a plant for the manufacture of the product, at Clinchfield (Va.). The plant, which is now in the preliminary stages of construction, will have a capacity of treating several hundred thousand tons of bituminous coal annually. The plans, indeed, allow for an eventual capacity of 1,500,000 tons per year. By a new process of low-temperature distillation, bituminous coal is treated in such a manner as to recover greater qualities of the valuable bye-products—such as toluol, sulphate of ammonia, and valuable oils. From the residue is made a fuel in the form of briquettes. Tests of "Carbocoal" by the Navy disclose that it contains less than 4 p.ct. volatile matter, rendering it practically smokeless.

SCOTTISH JUNIOR GAS ASSOCIATION.

WESTERN DISTRICT.

The opening meeting of the fifteenth session of the Association was held in the Royal Technical College, Glasgow, on Saturday. The chair was occupied by Mr. Thomas G. Moffat, of Tradeston, who automatically became President owing to the resignation of Mr. David T. Marwick, who has been appointed Works Superintendent to the Oxford Gas Company. The office of Vice-President had thus fallen vacant; and Mr. James Dickson (Kirkintilloch) was appointed. Mr. Moffat was unhappily handicapped in thus accepting office, by the recent death in London of his eldest son (who was in the R.N.V.R.), with whom he had been for some time.

PRESIDENTIAL ADDRESS.

Mr. Moffat proceeded to deliver his address, in the course of which he said: One of the principal assets of a gas manager is his power of imagination—*i.e.*, foresight—and to those who have been gifted with this, the past four years have been an experience they would not have missed. They have been able not only to carry on, but in almost every instance to increase their output—and this, too, with a daily increasing shortage of men and materials. The strictest economy with all kinds of materials, and the repairing of plant without having to apply for renewals, has led to the adoption of various appliances; and one we have found most useful is the oxy-acetylene welding and cutting process.

One of the repairs tackled was the building-up of the narrow-gauge railway crossings. These had got badly worn at the diamond, with the result that the small tip-up wagons were inclined to leave the rails at this point. The usual procedure would have been to have lifted the crossings out bodily (which meant at least two days' work, as the crossings were laid in position, and held there with a filling of concrete), and to have fitted a new diamond; so that a week would have been the shortest time to do this. With the oxy-acetylene flame, the only work to be done was the chipping away of the concrete around the part to be repaired, and applying the flame; and when the metal began to fuse, a rod of nickel steel was held in the flame till it melted, and was deposited on the top of the already-fused rail. The flame was then withdrawn, and the rail, while still hot, was well hammered. The flame was again applied, and more nickel steel deposited, until the worn part was built-up in line with the rest of the rail. The time taken to repair a crossing in this way was four hours; and so far it has proved entirely satisfactory.

Another operation with oxy-acetylene was the cutting-out of a number of 5-in. diameter holes through the webs of 8 in. by 5 in. rolled steel joists. These joists were for the supporting of the grids in the oxide purifiers; and, being of the two-layer type, the holes in the joists were for the easy passage of the gas from the inlet to the outlet. To drill a 5-in. hole by means of an ordinary radial drilling-machine requires a small hole to be drilled through the joist first, and a suitable cutter-bar inserted, and the hole widened-out with the cutter. To do this would take about four hours. With the oxy-acetylene process, after the holes had been marked off on the joists, the flame was applied, and in one minute the piece was cut out. These are two of many instances where oxy-acetylene has been used to advantage.

Another instance where saving was effected was the repairing of the bucket chains in the elevators conveying coal to the overhead hoppers. On examination of the chains it was found that the links were quite sound; but the bushings and pins were badly worn, and liable to give way at any time. To order a complete new chain would have been easy; but it would have been another question when we should have had delivery. By making application to the makers, however, we found them quite willing to supply us with the parts for repairs. Receiving the bushings and pins, a handy man was put on to take out the worn bushings, and replace them with new ones. This was quite simple, as the chain above and below the links to be renewed was held together by the aid of a union screw. A section was then removed, renewed, and put back again; and so on, until the whole chain was gone over.

In common with all gas-works, the want of suitable labour has been more and more felt as the days went on. We had to call upon our womenfolk; and right nobly they responded. We have been able, with their assistance, to fill the breach; and having found work that they could do, we were able to take the older men to do the more strenuous work required in the manufacture of gas. To show what women can do, I may say that at our works they are engaged in emptying coal from the railway wagons into the hoppers by means of hydraulic tippers; two men and two women doing the work of emptying daily anything up to 900 tons. A woman attends to each coal-breaker, with one man on each shift to start the engines and do all the overhead oiling. The women regulate the amount of coal passing to the breakers, and stop the engines when the hoppers are full. Then women are employed in trimming forward coke and breeze at the boilers; and they attend on the various tradesmen, and also shovel in the breeze wagons—all jobs that required men before the war. They deserve great credit for stepping into the smoke and grime of a gas-works to do their bit for the nation's welfare at so dire a time.

It does not take a great stretch of imagination to see the suc-

cessful conclusion of the war for the Allies; but the termination of hostilities is only the beginning of a war of industry, and gas-works, like all other industries of the country, will be affected. It is up to gas managers, and those in the industry, to see that all the gas, with its many bye-products, is extracted from the coal; for in past years very few have given a thought to the fact that at some future date coal will not be nearly so plentiful as it has been in the past, and should be looked upon as one of the finest assets of our country, and treated accordingly.

The Government desire that the production of gas be maintained, because of the valuable bye-products resulting from the carbonization of coal, and the national importance attaching to them. Every ton of coal goes further in meeting the requirements of the country if converted into gas, coke, &c., than if used in grates in its crude form. Now that calorific value has been accepted as the standard, it allows more scope for an increased make of gas and the recovery of benzol, &c. Our endeavour should be to keep hold of all the new consumers who have found it necessary to use gas since the war began—such as those who have installed gas-fired furnaces for tempering, annealing, and case-hardening, shell nosing, &c. All these furnaces can be easily adapted afterwards for the manufacture of bolts and nuts and drop-forgings of endless variety for motor car and engine construction.

Then, again, we have the running of commercial motors with gas. No doubt, many will say that huge flexible containers are unsightly; but once the law is altered to allow the use of gas under compression, the container will be quite small and hardly noticeable. And why should the law not allow these pressure containers, when they are already attached to railway carriages for lighting purposes? We have, further, the airship, which in the near future will become a successful rival to the present-day pleasure motor-car. These lighter-than-air machines will always find preference with many, for they are self-supporting.

It behoves all of us to be ever watchful, and on the alert.

DISCUSSION.

A short discussion followed the delivery of the address.

Mr. S. B. LANGLANDS (Glasgow) said he admired Mr. Moffat's insistence on the necessity of imagination in their work. They must have a big horizon. Research work, all improvement of detail—in fact, the whole of the work—would have an improved value if done with imagination. The remarks in the paper on oxy-acetylene welding were interesting. The subject was much to the fore with engineers. They were even going to tackle the building of ships by welding, instead of by riveting, though this was a matter for the future. A little in this direction had already been done. But what about welding with coal gas itself? Was this not a case where their imagination should come into play? It had been done by the Glasgow Corporation Tramways Department; and it was certainly up to the younger men to bring forward such ideas. He was glad to see Mr. Moffat so appreciative of women's work. In 1915, he (Mr. Langlands) had advocated the use of women in their works. He had had the pleasure of acting for the Ministry of Munitions on the dilution of labour; and going round the engineering shops in the Clyde district, and right down to Dumfries, he was struck by the amount of work done by women. The whole matter turned on this—if there was a good foreman, who took time at the outset properly to instruct the women, the work was well done. If the foreman did not take the trouble, the work of the women was not so good. On the subject of gas for motor traction, he thought they might take it that there would be no restriction on the use of containing cylinders after the war. The restriction was put on merely to prevent the work that would be entailed in making them, not because of the fears of danger in connection with the gas under compression in the cylinders. They had cylinders in use for many other purposes. The Wood-Milne people had excellent cylinders, not made of metal at all. They were stopped from making them; but he thought it was a question of employing necessary labour elsewhere.

Mr. DAVID FULTON (Helensburgh) said the gas industry as a whole had been lacking in vision. It had done too little itself, and left too much to be done outside. In connection with gas for driving motors, the container was not the difficulty; it was the pressure. They wanted to compress the gas to 1500 lbs. One firm he knew of had cylinders with gas compressed to 250 lbs. Six of them only ran a commercial car twelve miles. This was no good at all.

Mr. M'LAREN (Dumbarton) said the gas industry had a chance, under the needs of fuel economy, to forward the introduction of geysers in large houses heated by water circulation from a centre. The use of flexible containers for gas-driven vehicles had been a desperate necessity; but when one became accustomed to them, there was not a great deal wrong. Obtaining gas under pressure in the cylinders was certainly a difficulty. In 1910, a professional friend of his was consulting engineer for a syndicate who proposed to put on a gas-propelled car service from Blackpool to Fleetwood—he thought this was the run. He worked out the scheme for the syndicate, and finally pronounced it out of the question. In the first place, he found the gas could not be bought at a price comparable with petrol as it then stood. Secondly, he reckoned that to store the gas in cylinders it would require to be compressed up to 2000 or 3000 lbs. What would happen to the gas under such pressure? His friend had said that, supposing one got the gas at a price profitable against petrol, and supposing one had the cylinders for the pressure, he would not like to be near cars if they ran into each other.

Mr. J. S. M'NICOL (Dawsholm) thought that, in view of Mr. Moffat's insistence on the need for imagination, he should send his address to the Coal Controller. Speaking for Dawsholm, they obtained a large quantity of steam coal from Fife, and at the same time saw good Auchengeich coal going to the docks. The gas coal should be going to the places where it could be used to the best advantage. As for economy in coal, the day would come when gas would be of a lower calorific value, and at a price comparable with solid fuels.

Mr. A. SMITH (Tradeston) said he looked forward to someone giving them his experience in the compressing of gas for vehicles. He had had experience of what the Coal Controller had been doing in regard to Glasgow the past few months. In the summer time, it was known that they used that part of the year for the storing of coal; and he did not understand why the Conrtoller did not know it, or obtain the information. In his works, they had actually to take out of their meagre stocks in the summer time. There was something wrong there. When they had not suitable labour, and had such demands made upon them for gas for munition works, he could not understand how the material they got in the name of coal (it was not coal) could be sent to gas-works, while the better coal went past them for shipment. Their Allies must have coal; but if there were an all-round discrimination as to the class of coal allotted, there would be an improvement.

Mr. JAMES DICKSON (Kirkintolloch) said that in his works they had made much out of the experience of the war. Previously, they had got 8900 c.ft. per ton of coal; to-day they were producing 13,500 c.ft. Only three months ago, by their own labour, they had erected a small water-gas plant. Since the war, too, they had built a benzol plant of their own construction. With an increase of gas of about 4000 c.ft., they had had a saving of 40 p.ct. in coal, and of 40 p.ct. in stoking. Not only so, but they had less plant in operation than in 1914. They had saved something like 1500 tons of coal, and were producing practically the same amount of gas.

Mr. MOFFAT said they had not been fortunate enough to have plant at their disposal for coal-gas welding. It was really quite possible. It was adopted by the Tramways Department, but afterwards discarded. They had welded the rails close up together, and had not allowed for expansion. The cost of oxy-acetylene and electrical welding was very high; but to buy an oxy-acetylene plant was not very costly. In regard to the great compression of gas in cylinders, if they took the Diesel engine it exploded naturally at 700 lbs. It was a case of getting out of the way, if one doubled the pressure.

Increased Gas Price Sanctioned in Chicago.

The Illinois Public Utilities Commission have granted the Peoples Gas Light and Coke Company the right to increase their gas-rate to Chicago consumers approximately 27½ p.ct. In doing so, they point out the increases that have taken place as compared with normal times in the production costs of gas. The price of gas oil has gone up over 160 p.ct.; while the increased cost of solid fuel has been about 116 p.ct.; labour has gone up close upon 100 p.ct. The Commission say that it is a matter of common knowledge that, because of the unusual conditions brought about by the war, the operating expenses of public utility undertakings "have increased, and are likely to increase for some time to come, in a serious degree. The United States Government, realizing the situation as well as the necessity of keeping the public utilities of the country at the highest state of efficiency, and further realizing the necessity of enabling public utilities to be sufficiently supplied with money to operate their plants in a manner satisfactory to the public, have repeatedly indicated a feeling that increased rates for service should be permitted by State Commissions and other similarly regulatory bodies, where such increases are necessary for the efficient conduct of public utility business, and where such increases will not impose an undue burden upon the consumer. The Commission do not believe that the public should pay more than a reasonable price for public utility service; and yet a rate that a few years ago would have been unreasonable for such service may, under present war conditions, be considered reasonable." The record discloses that the 1917 earnings of the Company left a deficit, after paying bond interest for the year, of $365,201, which deficit had increased at the end of the first five months of 1918 to $953,116.

Indiana and a Heat Unit Standard.

As the result of a petition alleging inadequate service rendered by the Indiana Fuel and Light Company, the Public Service Commission of Indiana have made an order which will mark a complete change in the service regulations of gas companies over which they have control. Hereafter, when companies are benefiting by war-time surcharges in rates, the compensation for the Company's service will follow the actual furnishing of heat units by the Company. If they are to receive the full amount of the rate allowed from customers, they must keep the calorific power up to 600 B.Th.U. The Commission recognize that, in determining the proper bases for such standards, many perplexing and intricate problems are presented; and investigations are now being conducted by their engineering staff. A complete study of the matter will be made before final and permanent standards are adopted; but meanwhile the Commission will establish temporary rules which will recognize the relationship between heat units delivered and the price paid. The consumer will be charged the legal rate when the total B.Th.U. content averaged for the month (and arrived at under conditions set forth) does not fall below 590. When it does so, the consumer is to receive a rebate according to a table decided upon. Should the figure be between 590 and 580 B.Th.U., the rebate is to be 2·5 p.ct.; if it is between 500 and 490 B.Th.U., 24 p.ct.; and so on, until at 400 B.Th.U. the rebate will be 100 p.ct. There are also stipulations as to the purity and pressure of the gas. There is a note appended that the promulgation of a national war-time standard of 528 B.Th.U. per cubic foot, now contemplated by the National Fuel Administrator (or the adoption of any other standard), will necessarily require an adjustment of present rate bases, as well as a modification of the order here alluded to.

YORKSHIRE JUNIOR GAS ASSOCIATION.

A large gathering of members of the Association paid a visit on Saturday afternoon, under the presidency of Mr. E. Garsed, to the Dalton works of British Dyes, Ltd.

The inspection of the works—which was conducted under the guidance of Dr. W. B. Davidson and Messrs. G. B. Jones, C. R. Payne, and Merriman—afforded to the visitors a rough insight into many features of a kindred industry to their own, but to which they were entire strangers. Proceeding first by way of the shed for the manufacture of the intermediate product benzodine, the visitors were taken to the shed for the production of beta-naphthol—one of the most important intermediate products in making dyes. Passing up the magnificent main road, nearly a mile long, and 120 ft. wide, with railways up either side, and roadways branching away at right angles to communicate with the various departments, the parties were taken to the ice-house, where they were greatly interested in the process of manufacture, and particularly struck by the automatic labour-saving devices. It was mentioned, in passing over the central road, that the works as a whole cover an area of about 400 acres. In the para-nitreanaline house, note was taken of a small additional plant for evaporating down sodium acetate. The next point of special interest was the large house in which "T.N.T." washing occupies one end, and the remainder of the building is devoted to colour-making from the beta-naphthol, where the process of colour production was explained. The engineering stores were pointed out, and the vertical and horizontal retort-settings for making nitric acid—small affairs by comparison with the retort-settings of a gas undertaking—were examined.

As the party crossed the River Colne, which runs through the works, the guides mentioned trouble which had occurred during the recent heavy rains, by reason of a big rise in the river, resulting in the flooding of a considerable area of ground, and the complete isolation, for a few hours, of the Mond producer gas plant on the works. Particular interest was taken in the many stages of operations in the extensive oleum plant, and the sulphuric acid concentration plant; and then the visitors passed to the electric power house, and from there to the Mond gas plant (which has a set of six producers, each of from 12 to 18 tons per day capacity) which distributes its gas through more than 2000 yards of overhead mains. It was explained that the gas is not governed at all; and there is, as yet, no ammonia recovery. The plant is not pressed very hard, so long as it serves the purposes for which it is mainly intended. The producers are charged, roughly, about every half-hour, about 5 cwt. at a time. There is a continuous load on the oleum and concentration plants; but most of the other plants utilize the gas rather intermittently. It was explained that during particularly cold weather in the winter there was a brief stoppage in the oleum main; but it was cured by the gas receiving less cooling. The tour of the works concluded with a visit to the engine-house and the testing laboratories.

When the various parties had re-assembled in the offices,

The President said it was obvious that one could spend almost a lifetime looking round the wonderful works of British Dyes, Ltd., and then not know everything. The visit had been most interesting.

Mr. J. E. Lister Cooper, proposing a vote of thanks to Mr. J. Turner (the Managing-Director), to the Directors, and to Dr. Davidson and his colleagues, said the members had seen a wonderful place, and one which demonstrated the great progress which had been made in this country in the past few years in this class of scientific research. One thought of the time when quinine was very expensive, and the only dye was scarlet, made from madder root; when carbolic acid was exceedingly scarce, and yet all the time such a thing as coal tar was considered useless and a nuisance. Much honour was due to the long line of scientists who, during the past century or so, had developed research in coal tar. Great Britain had been very backward and slow to recognize and to use ability in chemistry, with the result that the Germans had got ahead in scientific activity; and we had been sending them the simple derivatives of dye, and importing their colours. Now this country had a place like that of British Dyes, and also men like Dr. Davidson and his colleagues, who were capable of investigating deeper into these matters.

Mr. E. J. Sutcliffe seconded the motion, and said he sincerely hoped that, by the time the war was ended, British Dyes would be in a position to displace all the dyes and coal-tar products which this country had previously obtained from Germany.

Dr. Davidson, in response, said the Directors had given him and his colleague a free hand in showing the visitors round. In a short visit, of course, it was impossible to take anybody through all the processes in detail. Some of the plants were of especial interest to gas engineers—notably, perhaps, the oleum plant. The works had not much in the way of a gas-producer plant yet, and had no ammonia recovery; but they might improve on this one day. There had always been a great brotherhood among gas engineers. They were always ready to receive visitors, and talk over each other's difficulties, and help each other towards remedies. This had not always been so in chemical undertakings; but he was glad to know that the former secrecy was now passing away. They could all learn much from the failures of others. The works there were on a very large scale. The undertaking had started well, by starting big; but this had its disadvantages. It was to be hoped that the works would be completed as speedily as possible after the war; and they might then really come down to the most serious business of competing with the German industry. The Germans had got a very long start; and it would take many years of hard work and research to entirely overtake them.

DIFFUSION OF OXYGEN THROUGH STORED COAL.

An account is given by Mr. S. H. Katz, in Technical Paper No. 170 of the United States Bureau of Mines, of a study of the rate of diffusion of oxygen through coal, which forms part of an extended investigation of the conditions affecting deterioration and spontaneous combustion of stored coal taken in hand by the Bureau under the direction of Mr. H. C. Porter, formerly their Chemical Engineer. The experiments described in this paper were carried out in an attempt to determine the effects of the size of the pieces of coal and the proportion of voids in a coal pile on the rate at which oxygen can be brought by diffusion from the air around the pile to the coal within—the purpose being to discover the bearing of diffusion on the rate of spontaneous heating within the pile.

When coal is stored in the air, the diminution of oxygen in the air within the mass, through oxidation of the coal, causes oxygen from the outside air to enter by both convection and diffusion, thus providing the means for further oxidation. The amount of oxidation from diffusion while air is entering by convection will vary with the magnitude of the convection. Hence the amount of oxidation that may be attributed to either convection or diffusion will differ greatly with conditions. Under some circumstances, air supplied by convection may act as the main source of deterioration and spontaneous combustion in stored coal; but the paper considers only diffusion and its effects. The results of the experiments show specially the importance of the proportion of voids in a mass of stored coal exposed to the air, in determining the possible amount of oxidation through oxygen entering the mass by diffusion. The amount of voids in any mixture of coal pieces can be kept low by having the large and small size coal uniformly mixed. In a mass of broken coal, through which oxygen is diffusing, the size of the pieces has (within practicable limits) no effect on the rate of diffusion, all other conditions being constant. The amount of oxygen diffusing through the interstices in a mass of coal pieces, seems to vary inversely as the depth of the coal. Sufficient experiments to justify a more definite conclusion than this have not been made. Coal stored in lumps or smaller pieces of uniform size contains a high proportion of voids, and oxygen diffuses readily through the mass. Mixing different sized pieces in a mass tends to reduce the proportion of voids. In storing coal in the air, factors other than diffusion may be accelerated or retarded by changes in voids; but if diffusion alone be considered, mixing the sizes of coal will reduce the oxygen entering the pile by diffusion. The building of a coal-pile so as to reduce or prevent segregation of the large and the small pieces will lessen the proportion of voids in the pile, tend to keep down the amount of oxygen entering the pile by diffusion, and thus reduce oxidation from this source.

Glasgow Public Gas Supply Centenary.

The public gas supply of Glasgow has reached its centenary; and the event has been marked by a luncheon at the City Chambers, presided over by Bailie Drummond, the Convener of the Gas Committee (followed by an inspection of the Dalmarnock and Dawsholm Gas-Works), and by the preparation of a brochure embodying many interesting facts—both ancient and modern. Some of the statistics showing the growth of the Gas Department will on the first opportunity be quoted in our pages; there is no space to do so this week. Suffice it to say now, that they constitute a striking record of progress—even in connection with the gas industry. It was in 1869 that the Corporation, finding the then existing works inadequate for the demands of the district, proceeded to the construction of new works now known as the Dawsholm works, and appointed the late Mr. William Foulis their Engineer. When the visitors inspected these works, they saw the installation of six benches of vertical retorts, 144 retorts in all, designed and patented by Mr. Alexander Wilson, the present Engineer and General Manager. These have more than doubled the productive capacity of the area that was occupied by the old horizontal retorts which they displaced. Mr. Foulis, after designing the Provan works, died while they were in course of erection; and it fell to Mr. Wilson to complete them. Sept. 5, 1818, was the date on which the first public street-lamp was lighted by gas made in the first public works in Glasgow; but it was not until nine years later that meters were introduced. The undertakings of the two Companies were transferred to the Corporation in 1869.

Combined Coal Gas Retorts and Generator Plants.—In the current issue of the "Journal of the Society of Chemical Industry" is an abstract of German patent No. 305,721 granted to Herr Strache, of Vienna, in 1916. According to this the producer described is operated with bituminous coal; and the mixture of producer gas and coal gas made during the period of blowing with dry air is utilized for heating coal gas-retorts. As soon as the temperature in the lower part of the producer is sufficiently high, the current of air is replaced by steam, and the water gas (which is also enriched with coal gas on passing through the layer of coal in the upper part of the producer) is led off through another outlet and mixed with coal gas from the gas-retorts.

CORRESPONDENCE.

[*We are not responsible for opinions expressed by Correspondents.*]

Winchester and Tar.

Sir,—I think you will agree that the future welfare of the gas industry, like other important matters, "depends now on plain speaking and straightforward action."

Fortunately the hour produces the man; and, almost accidentally, after three years of war, the Right Hon. Lord Moulton, K.C.B., F.R.S. (to use his own phrase) "commenced to make his intimate acquaintance with the gas industry." His lordship's great labour for the nation prepared the way for this intimacy, and for his sympathetic appreciation of the industry's present difficulties, as well as its reserve of power and great possibilities. With his finger on the pulse of our ambition, however, his lordship has detected in its beatings the causes of want of success—viz., isolation one from the other, and absence of competition among ourselves in the transformation of coal into the nation's vital necessities. Last week's messages to the industry from Lord Moulton and Sir Hallewell Rogers would doubtless be more effective if put into the hands of every gas committeeman and gas director throughout the country.

The foregoing are broad matters, but include the particular ones of organization and tar; and, "without attempting to soften what may seem harsh words," I would refer to the decided opinions on both subjects expressed in your last issue from Winchester.

There is not, I believe, a single municipally-owned gas undertaking in all the county of Hampshire, while the undertaking of its chief town is perhaps typical of many—small, old, and satisfied. And why not the latter, selling gas before the war at 3s. 8d., with a maximum price of 5s.? True, in 1917, 2d. of the difference disappeared, with the possibility of a little more to follow. Yet its profits are safe—a fact perhaps not unconnected with its advice to the Institution to "move very slowly," to "keep moving by all means, but move slowly"!

What does Winchester know of the calls and claims of great industrial centres in the Midlands and the North? Can the production of 86,000 gallons of tar in a year (which, after all, is but a veritable hair on the metaphorical tail) warrant the opinions expressed in your "Correspondence" column? I may have fallen from the sublime to the ridiculous; but that is the real point—the sublime is being marred by the ridiculous.

Oikonomia.

Oct. 25, 1918.

The Secretary of the Institution of Gas Engineers (Mr. W. T. Dunn) asks us to mention that on the 18th inst. thirteen volumes of "Transactions" of the Institution were delivered by a messenger; but he gave no information as to who had sent them. It is possible that the parcel came from one of our readers; and information which will throw any light on the matter will be appreciated by Mr. Dunn.

REGISTER OF PATENTS.

Ammonia Recovery Producer-Gas Process. No. 119,049.

Lymn, A. H., and Rambush, N. E., of Westminster Palace Gardens, S.W.

No. 8461; June 13, 1917.

In the manufacture of producer gas with ammonia recovery (as hitherto), in order to prevent the destruction of ammonia, it is necessary, the patentees point out, to introduce a relatively large quantity of steam with the blast, which, in practical working, amounts to about 2½ tons of steam per ton of fuel gasified. Only about 25 p.ct. of the steam takes part in the chemical reactions inside the producer; the remaining 75 p.ct. leave the producer undecomposed with the producer gas tar and ammonia. In consequence of this great excess of steam, the ammonia in the gas leaving the producer is only 0·2 to 0·7 p.ct. of the amount of steam present. The economical recovery of ammonia is therefore very irksome. If, as has been suggested, the gases leaving the producer were cooled to normal temperature, so as to condense the steam and absorb the ammonia in a similar way to that carried on in the manufacture of illuminating gas or coke-oven gas, a dilute condensate (in reference to ammonia) would be obtained. If, as has been proposed, for the purpose of obtaining a strong ammoniacal liquor solution from producer gas, the gas be led into water-cooled condensers, kept at between 38° to 71° C. to extract the tar, then through a tar-extractor from which tar and water of condensation flow back to the condenser, and then the gas from the tar-extractor be treated by the water of condensation to extract the ammonia, it would be uneconomical to absorb the ammonia by means of the condensed steam, owing to the fact that the partial pressure of the ammonia in the cooled gas is very small—*i.e.*, it varies generally between 1·5 and 5 mm. mercury (N.T.P.); and, consequently, a large portion of the ammonia would remain unabsorbed by the condensed steam, and would escape.

The usual practice is to neutralize the ammonia without condensation of the steam—*i.e.*, to neutralize at a temperature above the dew-point of the gas. For this purpose, the hot products from the producer are merely passed through a dust washer, in which they are cooled down to a temperature not materially lower than about 80° C. The still unclean gas is then passed through an ammonia-absorbing apparatus, where it comes into intimate contact with dilute acid. Thus practically all the ammonia is removed from the gas before the latter is cleaned. Although by this means the condensation of the steam is avoided, and a reasonably concentrated solution of ammonia salt is obtained, the latter is contaminated with tar. Moreover, only such acids can be used for neutralizing the ammonia as are stable at the process temperatures. With the object of avoiding these difficulties, it has been proposed to first separate the tar at above 100° C. by passing the gas through a spray of tar which has been separated from the gases and afterwards to separate water from the gases by passing them through a spray of water condensed from the gases—the ammonia being thereafter recovered from the gases by neutralization. In the process, however, the amount of condensed water would not be sufficient to condense all the moisture unless outside cooling means were used. Moreover, a number of operations and apparatus are required.

The present invention aims at overcoming the above-mentioned drawbacks, and provides an economical ammonia recovery producer-gas process and apparatus whereby a clean ammonia salt may be produced and an economical process carried out even when using such acids as are unstable at the temperatures of the present process.

The claims for the invention are:

1.—An ammonia recovery producer-gas process consisting in condensing and separating the steam and tar from the gas simultaneously and in one operation, without material absorption of ammonia, and thereafter absorbing and neutralizing in the cold the ammonia contained in the purified gas.

2.—A process (as set forth in Claim 1) consisting in removing the dust from the hot gases leaving the producer without reducing the temperature of the gases materially below 80° C., and then passing the gases through condensing means which are worked in such way that the gas leaving is practically freed from steam and tar, while the ammonia is carried away by the gases.

3.—A process in which the condensing means near the zone where the gas enters are kept at, or just above, the dew-point of the gas—*i.e.*, not materially below 80° C. (if necessary, by additional means)—so that ammonia which may have been absorbed by the condensate is continuously volatilized, whereas near the zone of the condensing means, where the gas leaves, the temperature is kept not materially above 40° C.; so that the steam and tar are condensed, while the ammonia passes away with the gases.

4.—Apparatus for carrying out the process, consisting in a tubular condenser adapted to be worked on the principle of a reflux condenser, and to be kept near the zone where the gas enters at, or just above, the dew-point of the gas—*i.e.*, not materially below 80° C.—so as to continuously volatilize ammonia which may have been absorbed by the condensate; the condensing means being adapted to be kept near the zone where the gas leaves at a temperature not materially above 40° C., so that the steam and tar are condensed, while the ammonia passes away with the gases.

Anti-Vibration Device for Incandescent Burners. No. 119,196.

Cahill, P. & P. J., of Dublin.

No. 5542; March 30, 1918.

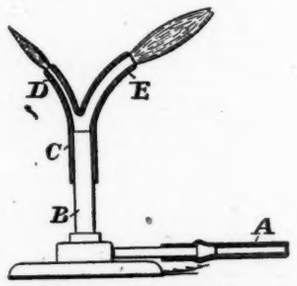
This invention relates to a shock-absorbing device applicable to incandescent gas-burners and lamps for the purpose of preventing damage to the mantles. It comprises a suspension spring fixed to, and backed by, a curved supporting bracket on the lamp-frame; being arranged to one side of, and out of the direct heat waves from, the mantle, and having its upper end holed to receive an adjustable hook provided with a lock-nut and wing-nut for raising or lowering the mantle. The hook has a loop or ring adapted to encircle and hold in spring-suspension the burner, in combination with a flexible tube on the burner remote from the mantle.

Bunsen Gas-Burners.—No. 119,278.

Esterly, A. H., of Atlanta, Georgia, U.S.A.

No. 13,844; Sept. 26, 1917.

The principal object of this invention is to provide an attachment for a bunsen burner whereby separate flames of different calibre may be simultaneously emitted in close proximity to each other from outlets the axes of which are inclined to one another.



Esterly's Double Bunsen Burner.

The illustration shows the burner nozzle applied to a bunsen burner of known construction.

The body of the burner is connected to a gas supply pipe A leading to the tubular burner stem B. The burner nozzle has the hollow stem C telescopically engaged with the stem, and the upper (or free) end bifurcated to form separate outlet branches D E curving outwardly away from each other. The bore and outlet orifice of the branch D are of relatively smaller calibre than in the branch E, so that the former will emit a "needle" flame while the latter will furnish a "brush" flame.

Utilization of Nitre Cake.—No. 119,290.

GROSSMANN, J., of Manchester.

No. 13,975; Sept. 28, 1917.

The patentee's principal claims are:

1.—A process for utilizing nitre cake for the production of nitric acid by heating-up to a temperature of 250° C. or thereabouts a mixture which consists of finely-ground nitre cake and sodium nitrate mixed with pieces of coke or other carbonaceous matter; the latter being in such quantity as will produce a friable saltcake, and preferably from about ½ in. in diameter upwards, so as to produce the practicably smallest quantity of nitrous gases.

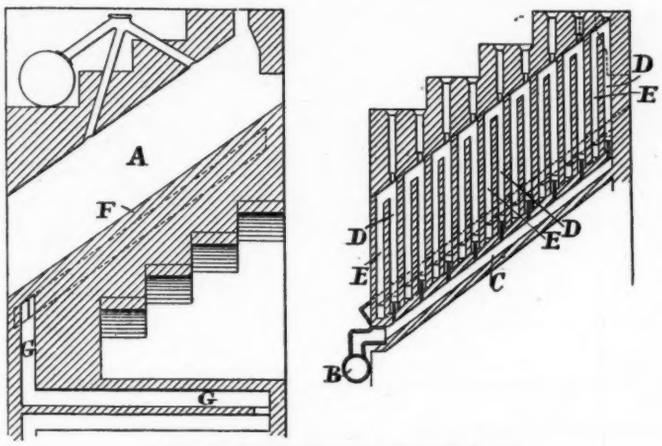
2.—Utilizing nitre cake for the production of hydrochloric acid by heating up to a temperature of 450° C. or thereabouts a mixture which consists of finely-ground nitre cake and sodium chloride, mixed (as before) with pieces of coke, so as to produce the practicably smallest quantity of sulphurous acid.

Heating Flues of Chamber Ovens or Retorts. No. 119,413.

SIMPSON, C. W., of Headingley, Leeds.

No. 6230; April 12, 1918.

This invention (relating to chamber ovens or retorts, either inclined or horizontal, for the carbonization of coal) consists "more particularly in an improved and simplified system or construction of heating flues for such chamber ovens or retorts"—as illustrated in vertical longitudinal sections through the oven or retort chamber and through the heating flues.



Simpson's Heating Flues for Retort Furnaces.

The gas for heating the chambers A is supplied by a pipe B running transversely in a horizontal direction in front of, and beneath, the level of the soles of the chambers, and having branches supplying the necessary amount to longitudinal gas-flues C beneath. The gas is thereby preheated by radiation from the refractory material, both of the chambers and of the return products of the combustion flues. Each gas-flue distributes the necessary volume of preheated gas to a series of burner blocks fitted with renewable nozzles, which can be changed according to the amount of gas required.

The air for combustion is preheated by passing through ordinary regenerators [not shown]. It then passes through longitudinal air flues N beneath the chambers, and is finally delivered to the burners at points immediately above the tips of the gas nozzles. This air supply is regulated according to requirements by damper-blocks.

Combustion takes place in vertical flues D serving as primary heating flues; and the products of combustion then pass downwardly through vertical flues E, serving as secondary heating flues; these primary and secondary heating flues being arranged in alternate longitudinal series in the walls separating the retort chambers. The products of combustion are then taken into return flues F beneath the chambers, whence they are delivered by flues G to the regenerators, through which they pass counter-current to the air supply flues.

Gas Reduction Regulators and Governors. No. 119,373.

STEWART, J.; a communication from J. G. TOOMS and R. KROG, of Christiania, Norway.

According to this invention, the reduction valve and its casing are mounted within a laterally disposed compartment of the low-pressure chamber or casing; and the diaphragm mounted upon the upper end of it has connected to it a rod mounted to have a vertical movement, while its lower end is connected to the end of an oscillating arm or lever mounted upon the end of a screw-threaded spindle of the valve.

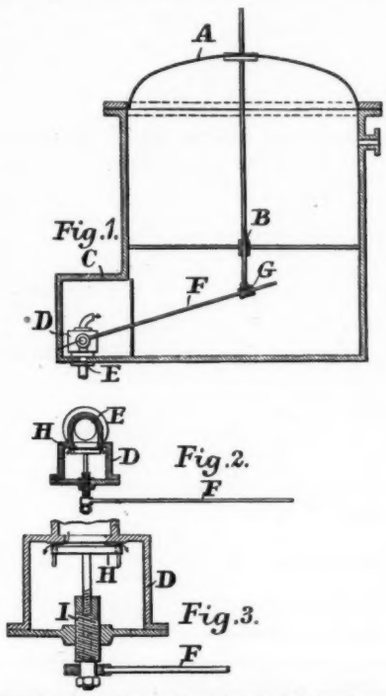
Fig. 1 is a sectional elevation of the apparatus; fig. 2 represents, on an enlarged scale, a sectional detail of the reduction valve and valve casing; while fig. 3 represents, on a still larger scale, a modified constructional form of the reduction valve and valve-casing.

The cylindrical vessel shown has an open top upon which a diaphragm A, of leather or other suitable material, is secured. A screw-threaded rod is centrally connected to the diaphragm; and a guiding boss B guides the rod in its upward and downward movement. A lateral compartment C contains the casing D of the reduction valve, which is connected on the inlet side to the high-pressure gas-supply pipe E. An oscillating arm F is mounted upon the end of the spindle of the valve, and a movable connection is made between it and the central rod through a pivoting sleeve G.

In fig. 2 the casing D is provided with a cover plate, through which the valve spindle passes—being screw-threaded through a boss in the cover so that as the central rod, and with it the oscillating arm F, is raised or lowered the valve spindle is rotated and the valve moved towards, or away from, its seat; so that the gas inlet is reduced or increased.

According to fig. 3, a quicker operation of the valve may be secured by the employment of a right and left hand screw device. Here the valve H is prevented from turning, being guided by the pins shown. The valve spindle is provided with an external right-hand screw thread, and can be screwed into or out of the tubular spindle I, which is provided with a left-hand internal screw-thread. The oscillating arm F is mounted upon the end of the spindle I, and its oscillations effect its inward or outward movement, and a consequent increase of travel of the valve H and its spindle.

By the arrangement of the reduction valve within the low-pressure gas chamber it is possible, the patentees remark, to dispense with all packing, and thus obviate excessive friction; and it is of no importance if there should be a small leakage through the reduction valve into the low-pressure chamber.



Tooms and Krog's Gas Regulators and Governors.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official List" for Oct. 23.]

Nos. 16,680—17,126.

BALLINGALL, J. M.—"Adaptation of dust, &c., arresting means to plant for manufacture of water gas." No. 16,711.

BATH, J.—"Holder for chimneys in gas-lamps." No. 16,791.

BENNETT, T. H.—"Gas fire-lighter." No. 17,091.

DEMPSTER, R. & J.—See Ballingall. No. 16,711.

DUNLOP, H. J. B.—"Apparatus for separating materials of differing densities." No. 16,782.

FISON, F. J.—"Self-contained gas-burner for lighting fires." No. 16,858.

HARVEY, E. W.—"Regenerative or recuperative gas furnaces for heating or melting metals." No. 17,068.

HARVEY GAS FURNACE COMPANY, E. W.—See Harvey. No. 17,068.

KESTNER, P.—"Filling-material for glover towers, &c., and means for producing same." No. 17,065.

LYNN, G. W.—See Fison. No. 16,858.

MORFETT, J. E.—"Apparatus for removing deposits of naphthalene in gas-mains &c." No. 16,760.

PARKES, H. C.—"Manufacture of nitrogenacids from ammonia." No. 16,827.

PEARSON, R.—See Parkes. No. 16,827.

SCHROEDER, F. W.—"Combined chimney and globe-holder for incandescent gas-burners." No. 16,994.

SPENCER, J. A.—"Grids for gas-purifiers." No. 17,015.

STEIGER, A. & W.—"Gas-fired shaft kilns for burning or roasting non-sintering substances." No. 16,758.

THOMPSON, H. S.—"Mantle-holders for incandescent lamps." No. 17,035.

The Alliance and Dublin Consumers' Gas Company have subscribed £210 towards the Dublin Mansion House Fund for the relief of the victims, and dependants of victims, of the sinking of the mail boat "Leinster" by enemy action in the Irish Sea.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

Progress of Bills.

The Commercial Gas Bill and the Portsea Island Gas Bill were brought from the Commons, read the first time, and referred to the Examiners.

The South Metropolitan Gas Bill and the South Suburban Gas Bill were read a second time, and committed.

HOUSE OF COMMONS.

Progress of Bills.

The London County Council have withdrawn their petition against the Bill of the Gas Light and Coke Company.

A Committee has been appointed, to meet on Nov. 5, to consider the South Shields Gas Bill and the Brentford Gas Bill: Mr. Mooney (Chairman), Mr. Perkins, Mr. Higham, and Sir John Fleming.

The London and South-Western Railway Company have withdrawn their petition against the Brentford Gas Bill.

The Gas Light and Coke Company's Bill was reported, with amendments.

Date for Calculating Supplies under the Rationing Order.

Captain Carr-Gomm asked the President of the Board of Trade what was the new and amended date of the commencement of the period for calculating gas and electricity supplies to consumers under the Household Fuel and Light Order, 1918, and whether he would take steps to make this alteration known to consumers in all parts of the country.

Sir A. Stanley replied that the period referred to commenced on the date of the meter readings for the quarter ended approximately Sept. 30 last. Steps had been taken to make this alteration known by publication in the Press throughout the country.

The Rationing Order and Candles and Lamps.

Captain Carr-Gomm asked whether the President of the Board of Trade was aware that, shortly after the publication of the Household Fuel and Lighting Order, 1918, householders were urged by official statements to use candles, night-lights, and oil-lamps in corridors and landings, so as to economize gas and electricity, whereas in a recent statement the use of such substitutes was denounced by the Coal Controller as being unpatriotic; and whether he could state what was the cause of these contradictory views being issued by the Coal Controller to householders.

Mr. Wardle (the Parliamentary Secretary to the Board of Trade), who replied, said the Controller of Coal Mines had no recollection of having made or issued contradictory statements with regard to the use of substitute fuel and lighting in replacement of coal, gas, and electricity. He had always emphasized the need for the utmost economy in all forms of fuel and lighting.

Proceedings under the Gas-Works Clauses Act.

The King's Bench Division of the High Court of Justice have allowed an appeal by Messrs. Samuel Allsopp & Sons, Ltd., from a decision in favour of the Birmingham Corporation of Judge Ruegg, K.C., sitting in the County Court. A motor-lorry owned by the defendants came into collision with a section-box attached to an electric standard belonging to the Corporation, and damage was done to the extent of £29 11s. The Corporation issued a summons against the defendants under section 20 of the Gas-Works Clauses Act, 1847, which provides that "every person who shall carelessly or accidentally break or damage any pipe, pillar, or lamp belonging to the undertakers, or under their control, shall pay such sum of money by way of satisfaction to the undertakers for the damage done, not exceeding £5, as any two Justices . . . shall think reasonable." The summons was heard, and the Justices awarded the Corporation £5. An action was afterwards brought by the Corporation in the County Court to recover the balance of £24 11s.; and Judge Ruegg gave judgment for the Corporation. Mr. Justice Rowlatt, in giving judgment, said that when a person had been awarded a sum of money, as in the present case, it was by way of compensation and satisfaction. Mr. Justice M'Cardie added that "satisfaction" meant "full satisfaction."

Claim against a Gas Company for Negligence.

In the King's Bench Division, last Monday week, before Mr. Justice Lush, Mr. Sydney L. Alberts, of Green Lanes, Palmer's Green, sued the Tottenham District Light, Heat, and Power Company for damages for negligence caused by the defendants or their servants. The Company admitted that their servant was negligent in the course of executing certain repairs, and that a fire broke out in consequence of it; but they denied that the fire caused all the damage alleged. The plaintiff carried on a fish restaurant; and on Dec. 1 last year he found it necessary to have some adjustments made in connection with his supply of gas. The defendants' man did the work so negligently that he left a small jet alight, with the result that in the evening the staircase was on fire, and the brigade had to be summoned. The result was that there was no gas for the evening, and no cooking could be done. He lost his trade and various things were injured; but the main damage was to the staircase, which amounted to about £25. Evidence was called on behalf of the defence, to the effect that the only fire that occurred was in the cupboard, and that the whole thing could be put right for £10. His Lordship said the claim had been greatly exaggerated; and in his opinion the £25 paid into Court by the defendants was enough. There would therefore be judgment for the Company; but plaintiff would have costs up to the time of payment into Court.

MISCELLANEOUS NEWS.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.

Post-War Developments in the Department of Chemical Technology.

In order fully to meet what seem to be the requirements of the post-war situation, on a scale commensurate with the responsibility of the College to the Empire, it is proposed that the future Department of Chemical Technology, under Prof. W. A. Bone, F.R.S., shall be organized so as to include four principal sections.

A.—Fuel Technology and Chemistry of Gases, with Refractory Materials.

It is suggested that this important group of subjects shall be located in the existing Fuel Block, which, however, it will be necessary to enlarge by the addition to it of two further storeys and its extension right up to the front of Prince Consort Road.

The principal subjects for which accommodation will be provided in such an enlarged east wing will be:

(*a*) General fuel technology, and the constitution of peats, lignites, and coals.
(*b*) The carbonization of coal and wood distillation.
(*c*) The chemistry of coal tar, ammonia, and the manufacture of intermediate products from coal tar.
(*d*) The chemistry of gases and technical gas catalysis, with special reference to new developments in the manufacture of ammonia, nitric acid, sulphuric anhydride, &c., resulting from the war.
(*e*) Refractory materials, clays, earths, and sands, used in furnace construction and the manufacture of ceramics, glass, and cements.
(*f*) Technical analysis connected with the foregoing.

It should be noted:

(1) That the arrangements contemplated under (*e*) would include some provision for investigating the materials used in the manufacture of optical glass, which it is hoped will be a useful adjunct to the new Department of Technical Optics.
(2) That those under (*b*) meet the need, already felt in many quarters, of adequate provision being made in this country for the scientific study of wood distillation, &c., in the interests of India and the Empire generally.
(3) That those under (*a*) will provide for an extension of the important investigations on lignites which have already been instituted in the Department during the war, in the interests of the Dominions.

B.—Chemical Engineering.

To be provided with suitable drawing offices and laboratories for advanced study and investigations upon:

(*a*) The materials and principles involved in the design, construction, and use of plant for such general factory operations as the transportation of solids, liquids, and gases; filtration, desiccation, extraction, distillation, evaporation, crystallization, &c.; condensing plant; the cooling, cleaning, and scrubbing of gases; the refining of solids, the concentration of acids; autoclaves and pressure plant, &c.
(*b*) The design and construction of foundations, flues, chimneys, &c.
(*c*) Factory economics and organization.

The underlying idea of this section of the Department's work is that students shall be trained in the working-out of designs of commercial plant from their own notes and experimental work, including the drawing-up of plans and specifications, and the organization of factories in which the above-mentioned operations are carried out. From an educational point of view, it has already proved to be a valuable feature of the Department's work; and it is hoped that its fuller development under the new scheme will greatly add to its efficiency and usefulness.

The other sections relate respectively to electro-chemistry; and the technology of carbohydrates, fats, oils, and rubber.

Industrial Connection.

In considering the development of the scheme as a whole, the importance should be emphasized of everything possible being done, both now and in the future, by way of establishing and extending connection between the various sections of the Department and the industries which they are severally designed to serve. This has already been done to a large extent in the case of the Fuel Section, where, for example, arrangements have been concluded with the Skinningrove Iron Company for completing the training of fuel chemists, &c., in their work; and an extension of other arrangements on similar lines should be encouraged whenever circumstances permit. It is also desirable that the Department should keep in close touch with the various organized efforts that are now being made to solve general industrial and economic problems by co-operative investigation and research.

The additional financial requirements for the important developments outlined are estimated at £100,000 for buildings and equipment, and not less than £10,000 a year for maintenance and working expenses.

Reduction in Price at Plymouth.—The Plymouth and Stonehouse Gas Company announce a reduction of 3d. per 1000 c.ft. in the price of gas. The present charge is 3s. 1d.; and the reduction will bring it to the level at which it stood up to last Christmas.

South Australian Gas Company.—For a time, the Newcastle coal strike was responsible for a considerable falling off in sales of gas by the South Australian Gas Company at Adelaide; but by the end of the year, the deficiency was made good. At Port Pirie, indeed, there has been so large an increase in the demand for gas, that sales were 26 p.ct. in excess of those of the previous year. There has, of course, been difficulty in securing materials, which resulted in only a small addition being made to the mileage of mains laid.

AUSTRALIAN GASLIGHT COMPANY.

Annual Meeting.

The Annual General Meeting of the Company was held in Sydney on Monday, Aug. 12—Mr. George J. Cohen (the Chairman) presiding.

The Secretary (Mr. R. J. Lukey) having read the notice convening the meeting, the report of the Directors was taken as read.

The Chairman, in moving the adoption of the report and accounts, said that in April last the Government appointed a Royal Commission to inquire into the cost of production of gas by the Australian Gas Companies; Mr. Justice Ferguson being appointed the Commissioner. The result was that the standard price was raised to 4s. 8d. per 1000 c.ft.—the amount the Companies considered they were entitled to. But after consultation with the Government, the Company decided that, for the present, the selling price should be 4s. 5d. Their Company were supplying gas at a lower rate than any other metropolitan city in Australia. This concession was made by the Board in view of the very heavy burdens already being borne by the community, consequent upon the disturbed conditions now prevailing owing to the war. The additional revenue from the increased price of gas would, he hoped, place the Company in the financial position that such an important and ever-increasing industry merited. The rate of dividend named in the Amending Act—8 p.ct.—should attract investors, and thus again place the Company in a position to carry out the extensions required on the works at Mortlake. The business of the Company continued to expand; the increase in the consumption of gas being 7½ p.ct. over the corresponding period of last year. The high price now being charged for coal, and the rate of wages at present being paid, would largely account for the increased cost of manufacture and distribution. Fortunately, residuals showed a satisfactory increase, particularly in respect of sulphate of ammonia. The profits would not permit of the payment of the new standard rate of dividend, or provide the full contribution to the special purposes and depreciation fund. He hoped, however, that on the next occasion, he would have the pleasure of reporting that they had been able to make the necessary provisions from the increased revenue, and that the Company would pay the full dividend allowed by the new Act. They might have noticed lately in the city one of the Company's lorries being driven by gas. This might be regarded as the outcome of the war, which had been responsible for the development of many inventions designed to meet the needs of the community. In England, these gas-driven lorries had been in use for some time. The lorry now being driven by gas was one of the Company's 30 cwt. Milnes-Daimler lorries, with the gas in a container overhead; and the lorry was so arranged that the power could be changed instantaneously from gas to petrol. The cost of the gas for running the lorry was one-third that of petrol at its present price; and the outlay on the conversion of the machine to use gas was only £35, which would be saved several times over in the course of a year. It was the Company's intention to make every endeavour to introduce the benefits of the system to lorry owners; and the Government were also interested in the introduction of gas for this purpose, in order to meet the necessities of the times. If sufficient encouragement was held out to the Company, means would be taken to supply the gas required from various stations throughout the city and suburbs, and an efficient and easy method of supply would be made available. With regard to the gas consumers, there had been a net increase during the half year of 1947; the number at present being 141,558. Had it not been for the impossibility of securing meters, and the inability to obtain mains for extensions, this increase would have been greatly augmented. Gas-cookers showed an increase of 952. They had always been enabled to maintain a stock of cookers, owing to the action of the manufacturers in protecting the Company's interests, notwithstanding the difficulties existing in England. Their action was greatly appreciated by the Directors.

It was with extreme regret that he had to announce the contemplated retirement of the Secretary, whose services during the many years he had been with the Company had been greatly valued. Mr. Lukey entered the service in 1889, as Assistant Secretary, having previously held the position of Secretary to the Falmouth Gas Company, in England; and upon the death of Mr. W. Johnston in 1895, he was appointed Secretary—being the third in succession since the formation of the Company. In a "Historical Sketch" published by Mr. Lukey in 1897, in commemoration of the Diamond Jubilee of the Company, he traced the progress of the Company from its inception. This was very marked; but since that year it had been even more phenomenal. Consequently, when Mr. Lukey retired, he would have the satisfaction of knowing that he had in no small measure contributed to the success which had placed the Company in the proud position of being the leading gas company in the Southern Hemisphere. He took this opportunity, on behalf of the shareholders as well as the Board, of expressing the wish that Mr. Lukey might be long spared to enjoy the well-merited rest and cessation from business cares, which had been exceedingly strenuous of late years.

The Hon. P. T. Taylor (Deputy-Chairman) seconded the motion, which was carried unanimously.

On the motion of Mr. F. W. Walker, seconded by Mr. H. de V. Scroggie, a vote of thanks was accorded the Directors and officers for their efficient management during the past year. Special reference was made to the contemplated retirement of Mr. Lukey; and there were expressions of appreciation of the valuable services rendered by him during the thirty years he had been associated with the Company.

The Directors of Meters, Ltd., have decided to pay, on account of the current year, interim dividends for the six months ended Sept. 30 last, at the rates per annum of 5¼ p.ct. on the preference shares and 5 p.ct. on the ordinary shares.

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COSTING AS APPLIED TO GAS UNDERTAKINGS.

Lecture by Mr. Edward Cooke, Accountant to the City of Birmingham Gas Department.

Of a course of five public lectures on cost accounts and efficiency methods now being delivered at the London School of Economics and Political Science (University of London), Clare Market, W.C., the fifth was given last Wednesday evening, to a large audience, by Mr. Edward Cooke, who took for his subject "Costing as Applied to Gas Undertakings." The chair was taken by Captain R. S. Hilton (the late Secretary and Manager of the department), who, in introducing the lecturer, said Mr. Cooke had worked for the Birmingham Corporation ever since he was a small boy. He had not only looked after the accounts of the largest municipal gas undertaking in this country—and he thought he might say in the world—but, in addition to this, he had done invaluable work since the war, first in connection with food control, and now with fuel control.

In opening, Mr. Cooke said that costing as applied to gas undertakings is a subject worthy of the serious attention of accountant students, though it had been put to him quite seriously on more than one occasion, by persons both inside and outside the gas industry, that there is no scope for a cost system in a gas undertaking, except in connection with the fittings and stove section, and possibly distribution. Cost has been defined as the amount or equivalent paid, or charged, or given for anything, loss of any kind, expenditure, or outlay as of money, time, or labour. This equivalent may be in the form of money paid for material or for labour, or for some one of the many kinds of expenses or loss that exist in every manufacturing business. It is apparent that cost consists of three elements—material, labour, and expense; and as these three elements enter so largely into the manufacture of gas, there cannot be any doubt that a real need exists for a cost system. Though the price at which gas can be sold to the consumer depends almost entirely upon the cost of coal, less the amount realized from the sale of residual products, yet the very heavy expenditure on repairs and renewals, together with power, lighting, and works standing charges, renders it necessary—particularly in a large works—to look closely into the costs, and see whether economies cannot be effected.

In view of the fact that the system to be set up must be one designed to deal mainly with wear and tear, rather than cost of production, the methods to be adopted will of necessity differ considerably from those required in a factory. In a gas undertaking, one commodity only is manufactured, and that from various qualities of coal, producing in turn varying grades and quantities of gas and residuals. Thus the cost of production can only be taken over a fixed period, and is usually obtained by dividing the wages of carbonizers and other retort-house men by the tons of coal carbonized or the thousands of cubic feet of gas produced, and adding to this figure the costs per ton or per 1000 c.ft. of the indirect charges—such as repairs of buildings and plant, fuel, foremen and timekeepers' wages, salaries of engineers and staff, &c. Such costs are taken out by every important undertaking once or twice a year; and some engineers hold that these records are sufficient for their guidance. But the industry occupies such an important place in the life of the nation, and the supply of cheap gas for industrial and other uses has now become of such vital importance, that a system whereby costs are only produced every six months is quite obsolete in these strenuous days. Granted that the cost of production does not vary very much from week to week—though diagrams show that it does so more than is often supposed—yet, as already remarked, the expenditure on repairs, and particularly on maintenance, is so exceedingly heavy and continuous that it can only be effectively controlled by a carefully-planned cost system designed to give weekly to the engineer and manager exhaustive information—especially as regards wages and stores—and with the least possible delay. One of the primary objects in keeping cost accounts is to enable an engineer or manager to check waste and to deal with any weak places in the running of a works; and while in a large gas undertaking a well-organized system of checking and controlling every branch of expenditure is not only desirable but really essential, yet it should be fully realized that to instal such a system will involve considerable trouble and expense. Unless, therefore, one is prepared to face this, it is better to do entirely without costs accounts, because an incomplete system is not only useless but a positive source of danger.

As time would not permit of an examination of the whole subject, Mr. Cooke confined himself to the manufacturing side of the business, fully describing, with the aid of specimen sheets and charts thrown upon the screen the system that has been adopted in Birmingham. He explained, however, that this has also been taken as a basis for a fittings cost system; and the results obtained have been such that distribution costs will be worked on the same plan, if the department decide in the future to do their own main and service laying, instead of putting it out to contract. Any system adopted must have as a basis the published accounts of the undertaking. It is now generally recognized that costs which are not reconciled with the general accounts are not worthy of serious study. The system he outlined can be adapted to a gas-works of any size; it being possible to make modifications or extensions without difficulty to meet local conditions. Remarking, however, that the production of the figures weekly in good time to be of real value will necessitate a large and extensive staff, unless liberal use is made of calculating and tabulating machines, the lecturer went on to describe the appliances of various types which are largely used by the Birmingham Corporation—including the comptometer, the Hollerith electric tabulating machine, the sorting machine, and the key punch. The essence of the system, he said, is that detailed costs shall be forthcoming immediately the money is expended. The responsible officials need information from week to week to enable them to obtain that intimate knowledge of their expenditure which is

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"READ THE PRESSURE BY THE POINTER."

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No glasses to break and nothing to clean.

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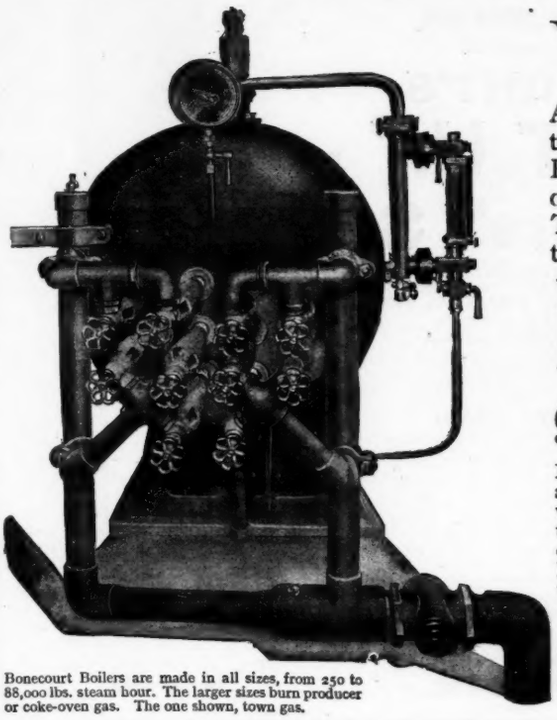
Three times the steam with far less gas.



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YOU can obtain more steam per cubic foot of gas from a Bonecourt Gas-Fired Boiler than from any other. A thermal efficiency up to 92·7% is obtainable with the Boiler and Feed Heater, which is far higher than that of other boilers operating on either Town or Producer gas, whilst its evaporative capacity is three times as great.

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A COMBINED HOT-WATER CIRCULATOR AND STORAGE-TANK FOR DOMESTIC, INSTITUTIONAL, AND COMMERCIAL USES.

GAS-HEATED.

Includes the Patent Thermostat, a valve that automatically controls gas-consumption, and all the other well-known features of the popular "B.T.U." Boiler. Special attention is now called to the latest improvement, known as the

"ECONOMY" VALVE.

The duplicate return connection with this new valve, fitted with indicator plate, gives a dual supply capacity to the storage-tank—(1) For baths, a large supply of hot-water is needed. With the "Economy" Valve full open, 20 gallons of water are heated and circulated. (2) For other purposes, a smaller quantity of hot-water is required. With the "Economy" Valve closed, only 6 gallons of water are heated and kept available. In either case the amount drawn off is immediately replaced in the storage-tank, heated, and kept available for use as often as required. The economy and convenience of this will be obvious.

Full Particulars on request to the Makers—

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HAVE PROVED TO BE SECOND TO NONE.

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Braddock's New Patent Retort-House Governor is a further improvement and is especially desirable for use with Vertical Retorts.

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Braddock's New Patent Enclosed Retort-House Governor. Latest Type.

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so vital to successful administration. It is beyond dispute that a scientifically designed cost system can be installed in any undertaking. New machinery is being continually brought into operation in the gas-making world, new methods and appliances are constantly under review; and no engineer or manager can get any idea regarding the effect these improvements are likely to have on his costs, unless he knows exactly what items are included in the total expenses over a given period. Items of cost are frequently lost sight of when totals only are presented; but if these totals are based upon detailed figures, easily and promptly accessible to the engineer, then it is possible for expenses to be in some cases reduced and in other cases eliminated altogether.

Some questions were put to Mr. Cooke by members of the audience; and in responding he said the actual cost of working the system he had described, as distinct from the accounting, was £2000; while the turnover of the department was £2,200,000.

Captain Hilton expressed their thanks to Mr. Cooke for his lecture. Having worked with him for something like eight years, he could say that Mr. Cooke's great value to the concern was not so much that he was an accountant, but that he was an accountant and an organizer. The lecture brought out the chief points in connection with any cost system. These were accuracy, promptness, and simplicity. As to accuracy, it was astonishing when one started a cost system to find how many costs people tried to estimate, instead of getting the cost out as ought to be done to the utmost farthing. They had had trouble with this in the past, and had decided that the word "estimate" should, if possible, not appear in their cost system; and in the end they did manage to eliminate it. As to promptness, they became able, by degrees, actually to work out the costs before the money referred to was paid to the workmen. The week's books were closed on the Wednesday night; the money was calculated out and was paid on Friday afternoon; and the costs were out on the Friday morning. This was on a wages bill of anything between £6000 and £7000 a week. The third point was simplicity; and here the diagrams that had been shown on the screen were of very material help. Those at the head of a large concern required the information they needed in such a form that they could easily assimilate it. Once there was a proper system to start with, and this was helped on by means of machinery, it was astonishing what information one could obtain—information one would never have dreamed of getting out in the old days of pens and paper.

In reply, Mr. Cooke said the cost system at Birmingham started in a very small way in 1909, and Captain Hilton came to the department in 1910; so that he took possession of it when it was very young. Really he felt that, in his lecture, he had been saying a good many of the things that Captain Hilton taught him. It was a great pleasure to work under him; and his leaving the Corporation was a great loss to the industry, and a sad one to the Gas Department. The lecture would be printed in full; so that those who desired to go closely into the matter would be able to obtain copies from him.

SERIOUS COAL OUTLOOK.

The Coal Controller has issued figures, which show a further serious falling-off in the estimated output of coal during the first 36 weeks of this year, compared with the output during the corresponding period of last year. The net shortage, it will be seen, is nearly 15¾ million tons, or about 8·8 p.ct.:

Period.	Output of Coal.	
	1918.	1917.
	Tons.	Tons.
1st four weeks ended Feb. 2, 1918	18,826,700	20,430,600
2nd " " March 2, 1918.	19,141,600	19,881,500
3rd " " March 30, 1918	18,759,700	19,840,400
4th " " April 27, 1918.	17,698,400	18,659,200
5th " " May 25, 1918	16,856,800	20,092,600
6th " " June 22, 1918	17,791,800	18,727,300
7th " " July 20, 1918	15,780,300	18,982,800
8th " " Aug. 17, 1918	16,042,200	17,769,200
9th " " Sept. 14, 1918.	17,724,600*	19,482,600
	158,622,100	173,866,200
		158,622,100
Deficiency.		15,244,100

* Provisional.

It will be observed that for the four weeks ended Sept. 14 it is estimated that 17,724,600 tons of coal were raised at mines in the United Kingdom, as against 19,482,600 tons during the corresponding period of 1917—a deficiency of 1,758,000 tons. It is estimated that on account of disputes at collieries, the output of nearly 435,000 tons of coal was lost. The stocks of coal at mines and in trucks on Sept. 14 were about 750,000 tons less than at the corresponding date of last year. There were 1,682,400 tons more coal raised in the four weeks ended Sept. 14 this year, compared with the output in the previous four weeks to Aug. 17—an increase of from 4 to 5 p.ct.

The output has steadily improved during the last three months, partly owing to the return of miners from the army, to the stoppage of the holiday season, and to a decline in the influenza epidemic; but the demand for coal is greater than ever.

Though the domestic rationing system is now in full operation, and the public are loyally responding to the demand for the most drastic economy in the consumption of fuel and light, the Coal Controller is faced with extra demands for many millions of tons of coal for the

Gas in War Time Industries

No. 13—Shell Parts.

Part of an installation of "Richmond" Regenerator Oven Furnaces, each 12 ft. long, for annealing copper blanks prior to pressing or drawing and cutting into small sections for shell driving bands.

THE RICHMOND GAS STOVE & METER CO., Ltd.,
WARRINGTON and LONDON.

requirements of the advancing Allied armies, for the navy, and for the manufacture of munitions. Even if peace were to come quickly, there is no prospect of a solution of the coal problem other than the economical one.

It is gratifying to report that the miners in many counties are responding to the appeal for increased output. During the four weeks ended Sept. 14 of this year, notable improvements were shown in the number of days worked by the miners in the following counties:

	Days per Week.		Days per Week.
Haddington	0·95	Durham	0·49
Worcester	0·58	Edinburgh	0·48
Monmouth	0·57	Northumberland	0·46
Pembroke	0·52	Carmarthen	0·43

IRISH LIGHTING RESTRICTIONS.

The Irish Coal Controller (Mr. H. G. Burgess) has drawn up, and the Viceroy (Field-Marshal Viscount French) has duly sanctioned, a Lighting Restrictions Order to meet the coal shortage situation, based on suggestions submitted by public authorities, manufacturing trades, and general mercantile and professional bodies.

It provides for the abolition of shop window lighting and lighting outside shops and other premises; and for the closing of shops, warehouses and offices at 5.30 p.m. on four evenings of the week, at 7 o'clock on Fridays, and not later than 9.30 on Saturdays—certain exceptions being made in favour of chemists' shops and establishments for the sale of temperance drinks, and those of hairdressers, tobacconists, and newsagents. But the quantity of gas or electricity used in these must not exceed 50 p.ct. of that used in 1914. Licensed houses are to close between 3.30 and 6 p.m.; and in hotels no meals are to be cooked after 8 p.m. The quantity of gas or electricity allowed to private houses, hotels, clubs, restaurants, boarding-houses, and to offices not working in conjunction with shops, warehouses, and factories, must not be more than two-thirds the 1914 quantity. All entertainments and assemblies must terminate not later than 10 p.m. In regard to these, there will be no restriction on afternoon performances or meetings during the Christmas and New Year holidays. Outdoor lighting of theatres is prohibited; and the allowance of gas or electricity to theatres and similar places must not exceed 75 p.ct. of the 1914 supply. Factories are to have preference for a supply of gas or electricity for power purposes; but the quantities used for lighting must not exceed 80 p.ct. of the 1914 quantity, except by special permit. Banks are to close at 2.30 p.m. The restrictions as to hours of closing up to 10.30 p.m. do not apply to Sundays. The quantities of gas and electricity used for public lighting must not exceed 50 p.ct. of that consumed in 1914.

The proposal that all shop window lighting and lighting outside shops and other business premises should be prohibited was criticized at a meeting of the Dublin Corporation by Sir James Gallagher, who said that if shop windows were not lighted in some way there would be danger in the streets; and Mr. J. J. O'Neill urged that licensed houses should remain open on Saturday evenings, as then there would be no extra demand on the light-producing plant. It is believed, however, that the proposal will be adhered to.

The Dublin Chamber of Commerce have expressed the opinion that a right of appeal to a representative tribunal should be granted, to meet cases of hardship that may arise under the restrictions.

PULVERIZED COAL SYSTEMS IN AMERICA.

Mr. Leonard C. Harvey, of Malden, Surrey, has returned from the United States after having carried out for the Director of Fuel Research a full investigation into the progress made in recent years in the application of pulverized coal for metallurgical and general industrial purposes, for steam raising in land and marine boilers, and in locomotives on railways.

The purpose of the Director of Fuel Research in accepting Mr. Harvey's offer to make this investigation was that the most recent information on the subject of pulverized fuel should be available to all who are interested in the more scientific use of fuel. In order that effect may be given to this intention, the information and data collected by Mr. Harvey, together with descriptions of numerous installations inspected, and statements as to the actual experiences of the owners of these installations, are now being collated in the form of a report. This report will at an early date be issued as a Government publication by the Department of Scientific and Industrial Research.

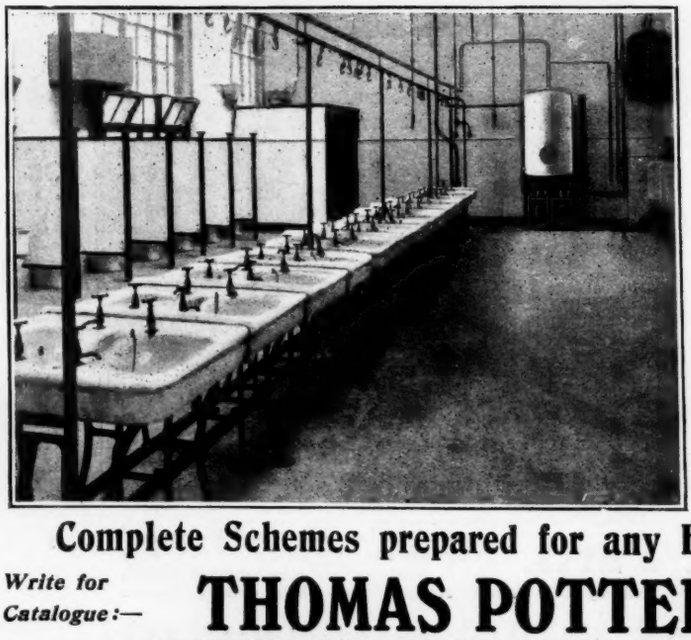
Important developments have taken place in America in the utilization in pulverized form of low-grade coals of high gas content; and it is hoped that similar developments will follow the adoption of the system in this country. It is possible that in this way considerable quantities of material which is at present regarded as waste at the coal-mines may ultimately be made available as fuel, and thus supplement the restricted supplies of coal.

In the near future, Mr. Harvey will read a paper before the Iron and Steel Institute which will deal in greater detail with certain applications of powdered coal as a fuel.

Patrick Casey, aged 40, an employee in the Tralee Gas-Works, was killed through getting entangled in a shafting of a gas-engine.

'VICTOR' GAS BOILERS

Reliability is proved by working results.



"Victor" Boilers are installed in numerous factories, canteens, etc., an example of which is here depicted supplying hot water for the lavatory block in one of the most important foundries near London—the fourth installation adopted by the same company since the outbreak of war.

Complete Schemes prepared for any Hot Water Requirement.

Write for Catalogue:—

THOMAS POTTERTON, HEATING ENGINEER AND PATENTEE,

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CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *Oct.* 28.

Business in London tar products remains practically in an unchanged condition. There are serious inquiries for pitch for export, and the minimum quotation remains at 65s. net per ton f.o.b. at makers' works. Solvent naphtha is worth about 3s. 9d. per gallon net and filled into buyers' packages. With respect to carbolic acid 60's, it is understood that the price arranged for October, November, and December deliveries is 3s. 6d. net per gallon, casks extra, *ex* makers' works.

All available supplies of sulphate of ammonia go readily into agricultural use, at the official price.

Tar Products in the Provinces.

Oct. 28.

The average values for gas-works products during the week were: Gas-works coal tar, 30s. 6d. to 35s. 6d. Pitch, East Coast, 44s. to 45s. per ton; West Coast—Manchester 35s. to 37s. 6d., Liverpool 35s. to 37s. 6d., Clyde 35s. to 37s. 6d. nominal. Benzol 90 p.ct., North, 10½d. to 11½d.; 50-90 p.ct., naked, North, 1s. 3d. to 1s. 4d. Toluol, naked, North, 2s. 3d. Coal tar crude naphtha in bulk, North, 7½d. to 8½d. Solvent Naphtha, naked, North, 2s. 11d. to 3s. Heavy naphtha, North, 2s. 11d. to 3s. Creosote, in bulk, North, 4¼d. Heavy oils, in bulk, North, 5d. Carbolic acid, 60 p.ct. East and West Coasts, 3s. 6d. naked, nominal. Naphthalene, £25 to £30; salts, £6 to £7, bags included. Anthracene, "A" quality, 6d. per minimum 40 p.ct.; "B" quality, 1½d. to 2d.

Manchester District Tar Prices.

The average price realized for tar in the Manchester district, based on the value of the products, for the month of September was 38s. 7d. per ton.

FROM A MARKET CORRESPONDENT.

Tar Products.

There has been more uncertainty and hesitation in the tar product markets than for some time past; the views as to peace and its effect being somewhat conflicting. Some dealers profess to believe in an

STOCK MARKET REPORT.

THE military history of the week was quite satisfactory—no dazzling successes, but a steady relentless push, uniform and systematic, with resultant progress on all fronts. But the Stock Exchange, by its movements, did not seem adequately to respond. Indeed, the opening days were actually dull, and, though there was no pronounced weakness except here and there for special reasons, yet buyers seemed decidedly stand-offish.

In the gilt-edged market, Home Government issues were weaker. The 5 p.ct. Loan was able to make a recovery; but Consols stayed down and marked 59½ more than once on Friday. Home Rails maintained their advance of the previous week, and were firm to the last. Canadians were a little better; but Argentines were fluctuating.

The Foreign Market died down very quiet, and weakened for lack of support. French 5 p.ct. was sold for market reasons, but steadied promptly, and Russians were not in demand. In Miscellaneous, Rubber had a dull time, and Shipping and warlike commodities were easy; but Oil was fairly good.

Business in the Gas Market was scarcely as abundant as in the week before, but not much below it; and a fair average of transactions was maintained. The two big issues, Gas Light ordinary and Imperial Continental, had the lion's share. The general tendency was excellent, and the recovery in prices was furthered. The only exception was in Imperial Continental, which had a momentary check to its late advance, and was 1 lower. All the rest of the variations in quotation, a goodly number, were in the upward direction, and were well spread throughout the list.

Bargains done for cash during the week were as follows: On Monday, Bombay 5, 5¼, Continental Union preference 72, Gas Light ordinary 74¾, 75, 75¼, 75½, Imperial Continental 128, 128½, 129, 129½, 130, Primitiva preference 65s., 66s. 3d., South Metropolitan 76, 76¼, 77, ditto debenture 55, Southampton 68, Wandsworth Wimbledon 72½. On Tuesday, British 31, Continental Union 51⅛, Gas Light ordinary 74½, 74⅝, 75⅛, Imperial Continental 127, 127½, 128, 128½, 130, Primitiva 45s., 46s. 3d., 47s. 6d., ditto preference 66s. 3¾d., 67s. 6d., 70s., ditto debenture 77, San Paulo preference 7⅜, South Metropolitan 76, 76¼, 76⅜, South Suburban 71, Southampton 70½, Wandsworth Epsom 72, British 3 p.ct. debenture (Norwich) 50½. On Wednesday, British 31½, Gas Light ordinary 74½, 74⅝, 74⅞, 74⅝, 75, ditto preference 68½, 69, Imperial Continental 127, 127½, 128, 128½, 129, Monte Video 9, Primitiva 43s. 9d., 45s., 46s. 3d., ditto preference 66s. 3d., South Metropolitan 76, ditto debenture 55⅜, South Suburban 71¾, 72. On Thursday, Alliance and Dublin 52, Brentford "B" 71, Brighton and Hove original 135, ditto ordinary 95, 95½, European 12½, 12⅝, Gas Light ordinary 74½, 74⅝, 74⅞, Imperial Continental 126, 127, 127½, 128, Primitiva 45s. 3d., 46s. 3d., ditto preference 68s. 9d., 70s., Wandsworth Wimbledon 74. On Friday, Alliance and Dublin 52, 52½, Brentford "A" 80½, European 12½, 12⅝, Gas Light ordinary 74½, 74⅝, 75, Imperial Continental 126, 126½, 127, 127½, 129, Primitiva 43s. 9d., 45s., ditto preference 68s. 9d., 71s. 3d., South Metropolitan 76½, 76¾, Southampton 71.

In the Money Market, a good demand kept rates very firm. The Bank rate is 5 p.ct., as fixed on April 5, 1917.

ANTE-WAR PRICES AND DIVIDENDS, LATEST DIVIDENDS, AND LAST WEEK'S BARGAINS.

Issue. £	Shares.	When ex-Dividend.	Ante-War Dividend & Bonus p.c.	Last Dividend.	NAME.	Closing Prices, July 30, 1914.	Present Prices.	Lowest and Highest Prices of Bargains.
182,049	Stk.	Mar. 10	4	4%	Aldershot 4 p.c. Pref.	..	55—60	..
1,551,868	"	April 8	2½	4⅛%	Alliance & Dublin Ord.	59—64	51—56	52—53½
974,000	"	July 10	4	4%	Do. 4 p.c. Deb.	76—79	62—67	..
290,000	5	April 29	7½	8%	Bombay, Ltd.	5⅛—5⅜	5—5⅛*	5—5⅛
50,000	10	Feb. 26	16	11%	Bourne-mouth Gas and Water { 10 p.c.	23—30	21—28	..
883,110	10	"	7	7%	B 7 p.c.	15—15½	10—11	..
115,000	10	"	6	6%	Pref. 6 p.c.	13½—14	9—9½	..
159,740	—	—	—	4%	4 p.c. Deb.	..	66—68	..
992,045	Stk.	Feb. 26	14	4⅛%	Brentford A Consolid.	281—286	78—81	80½
794,920	"	"	11	4⅛%	Do. B New	204—209	69—73	71
55,000	"	"	5	5%	Do. 5 p.c. Pref.	109—111	77—82	..
221,460	"	June 11	4	4%	Do. 4 p.c. Deb.	91—98	62—64	..
217,880	"	Feb. 26	11	8½%	Brighton & Hove Orig.	208—213	135—140	135
244,200	"	"	8	5⅛%	Do. A Ord. Stk.	154—159	93—98	95—95½
680,000	20	Mar. 26	12½	23/6	British	44—45	31—32	31—31½
190,000	Stk.	June 26	4	4%	Do. 4 p.c. Deb. Stk.	88—90	64—66	..
245,771	"	"	4	4%	Buenos Aires 4 p.c. Deb.	85—87	51—54	..
100,000	10	—	—	—	Cape Town & Dis., Ltd.	1½—2½	3⅜—4½	..
100,000	10	—	—	4½%	Do. 4½ p.c. Pref.	4—6	7⅜—8½	..
100,000	Stk.	June 26	4½	4½%	Do. 4½ p.c. Deb. Stk.	70—75	60—65	..
157,150	"	Feb. 26	5	5%	Chester 5 p.c. Ord.	108—110	79—81	..
1,518,280	"	Feb. 12	5/9/4	30/-	Commercial 4 p.c. Stk.	106—108	60—65	..
650,000	"	"	5½	30/-	Do. 3½ p.c. do.	103—105	57—62	..
475,000	"	June 11	8	8%	Do. 3 p.c. Deb. Stk.	69½—71½	52—54	..
800,000	"	"	4	—	Continental Union Ltd.	76—79	50—58	51½
200,000	"	"	7	—	Do. 7 p.c. Pref.	115—118	70—75	72
275,400	—	—	—	10½%	Croydon B and C 7 p.c.	..	140—150	..
—	—	—	—	10%	Do. E	..	..	..
492,270	Stk.	—	6	6½%	Derby Con. Stk.	123—126	95—100	..
55,000	"	—	4	4%	Do. Deb. Stk.	102—104	80—83	..
1,002,180	10	July 29	10	5/0	European, Ltd.	17½—18	12—13	12½—12⅝
16,398,975	Stk.	Feb. 10	4/17/4	29/4	Gas Light & Coke { 4 p.c. Ord.	98—102	74—76	74½—75⅜
2,600,000	"	"	8½	8½%	8½ p.c. max.	76—79	54—56	..
4,003,326	"	"	4	4⅛%	4 p.c. Con. Pref.	96—99	67—69	68½—69
4,674,850	"	June 11	8	8⅜%	3 p.c. Con. Deb.	72½—74½	54—56	..
180,000	"	"	10	10⅜%	10 p.c. Bonds	..	..	..
256,740	"	Mar. 12	5	2⅜%	Hastings & St. L. 5½ p.c.	87—89	45—50	..
70,000	10	April 29	11	6%	Hongkong & China, Ltd.	16½—16⅝	7—8	..
86,500	—	—	—	9½%	Hornsey 7 p.c.	..	112—117	..
181,000	Stk.	Mar. 12	7½	6⅛%	Ilford A and C.	151—154	90—95	..
65,780	"	"	6½	4⅜%	Do. B	115—118	69—74	..
65,500	"	June 26	4	4%	Do. 4 p.c. Deb.	92—94	62—65	..
4,940,000	"	May 14	9	4½%	Imperial Continental	150—160	125—130	126—130
1,295,000	"	Feb. 12	8½	8½%	Do. 8½ p.c. Deb. Red.	84—86	71—73	..
236,342	"	Mar. 12	6½	6½%	Lea Bridge Ord. 5 p.c.	119—121	93—98	..
2,498,905	"	Feb. 26	10	5%	Liverpool 5 p.c. Ord. { A	146—148	82—84	..
					{ B			..
306,088	"	June 26	4	4%	Do. 4 p.c. Pr. Deb. Stk.	..	71—73	..
75,000	5	June 11	6	3%	Malta & Mediterranean Mut. of Melbourne { 4½ p.c. Deb.	4⅛—4⅜	3½—3⅝	..
250,000	100	April 1	4½	4½%		99—101	87—98	..
541,920	20	May 28	4	6/-	Monte Video, Ltd.	11½—12	8⅜—9½	9
1,875,892	Stk.	July 29	4½	3⅛%	Newcastle&Gateh'd Con.	96½—99½	67—69	..
539,705	"	June 26	3½	3½%	Do. 3½ p.c. Deb.	85—88	59—61	..
55,940	10	Feb. 26	7/14/0	7%	North Middlesex 7 p.c.	14—15	9½—10½	..
800,000	Stk.	May 14	8	8%	Oriental, Ltd.	117—122	103—104	..
60,000	5	Mar. 26	10	1/-	Ottoman, Ltd.	7½—7⅝	4—5	..
60,000	50	Feb. 26	18	9%	Porisea, Island B	128—131	73—83	..
100,000	50	"	12	6%	Do. C	118—121	73—78	..
53,000	50	"	10	6%	Do. D	..	..	..
249,980	5	April 29	8	—	Primitiva Ord.	5—6	2⅜—3⅜	43.9—47/6
499,960	5	June 26	5	2/6	Do. 5 p.c. Pref.	4½—6	3⅛—3⅞	65/—71/3
621,600	100	June 2	4	4%	Do. 4 p.c. Deb.	91—98	75—77	77
—	—	—	—	4%	Do. " 1911	..	50—55	..
346,198	Stk.	June 26	4	4%	River Plate 4 p.c. Deb.	85—87	55—60	..
150,000	10	May 14	6	6/	San Paulo { 6 p.c. Pref.	10½—11	7½—7⅝	..
135,000	Stk.	Mar. 12	10	10%	{ 5 p.c. Deb.	47—49	42—43	7⅜
209,984	"	"	10	10%	Sheffield A	228—234	170—173	..
528,500	"	"	10	10%	Do. B	229—234	170—173	..
90,000	10	May 28	9	6/-	Do. C	230—232	168—172	..
6,609,895	Stk.	Feb. 10	5/4/0	32/-	South African	10½—11½	11½—12⅜*	..
250,000	"	July 12	—	5%	South Met. 4 p.c. Ord.	111—113	75—77	76—77
1,895,445	"	July 10	3	3%	Do. Pref.	..	91—93	..
294,893	"	Feb. 26	8½	6%	Do. 3 p.c. Deb.	73½—74½	54—56	55—55½
962,795	"	"	6	3½%	South Shields Con. Stk.	157—159	118—119	..
60,000	"	"	5	5%	S'th Suburb'n Ord. 5 p.c.	114—116	71—74	71—72
185,000	—	—	—	3½%	Do. 5 p.c. Pref.	110—112	73—75	..
187,558	Stk.	June 26	5	5%	Do. West Kent	..	..	..
647,740	"	May 14	5	3%	Do. 5 p.c. Deb. Stk.	116—118	83—85	..
120,000	"	Feb. 12	7½	5⅛%	Southampton Ord.	99—102	68—71	68—71
792,275	"	"	6	4%	Tottenham { A 5 p.c.	135—138	99—97	..
181,255	"	June 26	4	4%	District { B 3½ p.c.	115—117	87—89	..
189,380	10	Dec. 30	5	—	{ 4 p.c. Deb.	87—89	61—63	..
149,900	10	July 1	5	5%	Tuscan, Ltd.	5—6	1—2	..
295,476	Stk.	Mar. 12	5	5%	Do. 5 p.c. Deb. Red.	93—95	45—50	..
					Tynemouth 5 p.c. max.	103½—109½	87—88	..
					Wandsworth, Wimbledon, and Epsom—			
90,000	"	Feb. 26	8⅜	63/9	Wandsworth A 5 p.c.	151—156	90—95	..
255,686	"	"	6⅞	48/9	Do. B 3½ p.c.	129—134	70—75	..
108,075	"	"	5/17/3	44/7½	Do. C 3½ p.c.	110—115	70—75	..
852,000	"	"	6½	42/6	Wimbledon 5 p.c.	117—122	70—75	73½—74
98,000	"	"	6⅞	48/9	Epsom 5 p.c.	121—126	73—77	73
88,416	"	June 26	3	3%	3 p.c. Deb. Stk.	66—69	49—52	..

* Ex Div.

early peace, but seem unable to gauge its effect. On the other hand, there are some who do not expect any radical change, as they do not anticipate an early termination of hostilities. A meeting of the trade has recently been held in the North to deal with the pitch situation; but there is no definite news as to what decisions have been reached. There is also an official order placing pitch in Class "B" for export, which means that licences will be necessary for export orders in the future. It is difficult to see the reason or intent of the order, unless it be to keep prices from rising, or to bring them down. London quotations are steady at 65s. Sales have been made in the Provinces at 40s. per ton; and the market seems quite strong. Only moderate quantities are being taken for blending with creosote oils; but at 40s. per ton the authorities are left with an oil cheap in contrast with petroleum derivatives. Solvent naphtha has improved in London, while in the Provinces quotations are rather uncertain. Consumers are simply buying from hand to mouth, and look for a sharp fall in prices if the war should soon end. This is a one-sided view, as the present demand is due to war orders; and their consumption depends on these. On the other hand, the private demand for rubber goods will rapidly increase after the war; and it is somewhat difficult to appreciate the former line of argument. Heavy naphtha is just steady. The trade in refined naphthalene is poor at present; but crudes experience a big demand, and prices are firmly held. Rumours are current that an arrangement has been come to with regard to carbolic acid prices, and that crude 60's will not be less than 3s. 6d. per gallon. Details, however, are not available. Crystals 40 p.ct. now make 1s. 8d. to 1s. 10d. The tar purchase proposals are still strongly criticized in trade circles. Other products are without alteration.

The range of quotations is as follows:

Benzol: 90% London, 1s. 0½d., North 10½d. to 11½d.; 50% North 1s. 4d. to 1s. 5d. naked per gallon.

Carbolic Acid: 60% East and West Coast 3s. per gallon; crystals 40% 1s. 8d. to 2s. per lb.

Crude Tar: London 39s. to 41s.; Midlands 33s. to 35s.; North 32s. to 34s. per ton *ex* works.

Pitch: London 65s. per ton f.o.b. works; East Coast, 36s. 6d. to 37s. 6d.; West Coast, 37s. 6d. to 40s. f.a.s.; Manchester, 39s.; Clyde, 41s.; South Wales, 45s. per ton.

Solvent Naphtha: London 3s. 3d. to 4s.; North and Midlands 3s. to 3s. 6d. per gallon.

Crude Naphtha: Naked 30% 8½d. to 8¾d.; North 6½d. to 6¾d.

Naphthalene: Refined £28 per ton nominal; salts 80s., bags included.

Toluol: Naked, London 2s. 4d.; North 2s. 3d.

Creosote: Nominal, London 4¾d.; North 4d. to 4¼d. (Government price, 75s. per ton f.o.b.—equal to 4½d. per gallon); heavy oil, 4¼d. per gallon in bulk.

Anthracene: "A" quality, 40-45%, 4¾d. per unit; "B" quality, 1¾d. to 2¾d.

Cresylic Acid: 95%, 3s. per gallon; 97-99%, 3s. 3d. to 3s. 6d. per gallon, casks included, *ex* works London and f.o.b. other ports.

Grease Oils 18° Tw. (naked) £6 per ton f.o.r. makers' works.

Sulphate of Ammonia.

The demand for home purposes remains good; and there is no fresh development in the position. Our allies require very heavy quantities, which cannot be fully supplied, although the authorities are releasing as much as possible, having regard to our own urgent needs. Neutral countries also would be glad to pay very much higher prices than those ruling if they could obtain supplies; but there is nothing available.

Lighting of Dungannon.—The suspension of public lighting in Dungannon (co. Tyrone) caused so much inconvenience, that the Gas Company last week decided to light a number of lamps from 5 to 10 o'clock each evening; the work to be carried out by Urban District Council employees.

South Suburban Gas Company's War Savings Association.

The employees of the South Suburban Gas Company (a co-partnership Company) have for some considerable time been running a War Savings Association on somewhat different lines from the ordinary Association. The operations are carried on in cycles of 31 weeks. Each member fills in a form stating the number of war savings certificates he or she desires to take up, and authorizes the Company to make deductions from wages due each week to the amount of the subscription, which is 6d. for each certificate. A number of certificates are purchased each week to the value of the aggregate subscriptions, and are balloted for; each member having one chance in the ballot for each certificate subscribed for. If a member leaves the Company's service, or desires for other valid reason to withdraw, if unsuccessful in the ballot his or her subscriptions are refunded; while if a certificate has been allotted, the balance of the purchase price is deducted from the wages due, and the certificate duly handed to the member. Under this system every member receives a certificate by the time the last payment is made, and has a chance of having one allotted long before payments are completed. Three cycles have been run, and a fourth is about to commence. Up to the present, £2961 5s. 6d. has been invested under this arrangement by about 350 members. The Association is administered by a Committee of Employees; the Company defraying all expenses—printing, books, &c.—incurred in connection with it.

Tipperary Maximum Gas Price.—The Tipperary Gas Company, Ltd., are seeking Board of Trade modification of an Order issued in May allowing a charge of 5s. 6d. per 1000 c.ft. of gas, so as to fix the price at 8s., subject to an increase or decrease of 1d. per 1000 c.ft. for every 1s. rise or fall in the cost of coal from the present figure of 58s. 2d. per ton.

Fuel Consumers' (Returns) Order, 1918.—Under an Order dated Oct. 18, all persons who consume 2 tons or over of fuel in any week, or whose yearly consumption is reasonably estimated to exceed 100 tons, are required to make a return to the Coal Controller not later than to-morrow (Wednesday). The Order does not apply to fuel in respect of which returns are already made to the Coal Controller, to fuel supplied under the provisions of the Household Fuel and Lighting Orders, and to fuel used solely for agricultural purposes or for steam lorries.

Leeds Gas Consumers and Economy.—Data prepared by the local authorities at Leeds show evidence of considerable economy in the use of gas and fuel generally; the assumption being that people are going to bed earlier. The music halls find their biggest audiences are those of the "first house;" and the tramway service is busiest between 9.30 and 10 p.m. Mr. C. S. Shapley (the new Engineer and General Manager of the Gas Department) reports that the household supplies show a reduction of about 20 p.ct., which is attributed to a reduced consumption not only in lighting but also in heating and cooking.

Flat and Office Lighting.—It has been brought to the notice of the Coal Mines Department by local Fuel Overseers that many occupiers of flats and offices appear to think there is no need to send the usual application form to the local Fuel Overseer unless they use coal. All consumers of more than 22,500 c.ft. of gas or 120 B.o.T.U. of electricity a year have to apply for an assessment; and the forms can be obtained from the gas or electricity undertakings, if the consumer does not buy coal. If the flat or office is part of a block where the heating is supplied by the landlord or main occupier, or if the gas or electricity is supplied by a sub-meter from the general supply to the building, the premises may be decided by the local Fuel Overseer to be a case for one joint assessment; and occupiers under these conditions should inquire from their landlords in the first instance.

WANTED, FOR SALE, CONTRACTS, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Appointments, &c., Vacant.

Engineer and Manager. Silsden Gas Department. Applications by Nov. 4.

Engineer and Works Manager. Cork Gas Company.

Assistant Manager. Stoke-on-Trent Gas Department. Applications by Nov. 12.

Assistant to Manager. Leighton Buzzard Gas Company.

Technical Assistant to Manager (Gas Apparatus). No. 1517, care of R. F. White & Son, Fleet Street, E.C.

Assistant Chemist. Barnet Gas and Water Company.

Appointments, &c., Vacant (*Continued*).

Carbonizing Foreman. Chesterfield Gas-Works.

Carbonizing Foreman. Barnet Gas and Water Company.

Junior Works Assistant. No. 6519.

Night Foreman. No. 6521.

Brass Finisher. No. 6520.

Appointments, &c., Wanted.

Foreman or Charge Hand. No. 6522.

Gas-Works for Sale.

Eastern Counties. No. 6518.

Plant, &c., for Sale.

Biggs-Wall Hand Charging Machine. Clevedon Gas-Works.

Cast-Iron Pipes. No. 10, Hawkins Street, Dublin.

Iron Sheets. Erector, Leeds.

TENDERS FOR.

Coal and Coke Handling Plant.

Manchester Gas Department. Tenders by Nov. 14.

Resetting Retorts.

Manchester Gas Department. Tenders by Oct. 31.

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FOR SALE OUTRIGHT, OR ON LOAN

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Palmerston House,
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Resists 4500° Fahr. Best for Gas-Works.
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BAGLEY, MILLS, & CO., Ltd.,
92, Victoria Street, Westminster, S.W. 1, Invite inquiries from all Gas-Works making 75 million cubic feet and upwards per annum.

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